~~MULTI-POINT SEAT-BELT~~ANTI-SUBMARINING SEAT-BELT ASSEMBLY

CROSS REFERENCE TO RELATED APPLICATIONS

This is an ~~divisional~~ application of US-serial number 10/690,742 related to a division of an international application number PCT/DE98/03270 (WO 99/24294, European Patent EP 1 037 773 B1, German Patent DE 197 49 780 C2) filed Nov. 10, 1998.

~~This is related to an international application number PCT/DE98/03270 (WO 99/24294, European Patent EP 1 037 773 B1, German Patent DE 197 49 780 C2) filed Nov. 10, 1998.~~

BACKGROUND OF THE INVENTION

1. Field of the Invention:

It is an object of the present invention to ~~ensure~~ prevent ~~the restraint of~~ a restrained passenger of a transport system (motor vehicle, ship, train or aeroplane) from submarining, absorb impact energy of the passenger and dampen vibration ~~in order to enhance the survival chance associated with lowering all acceleration dependant forces~~ in the event of any accident (front-, side-, rear-end collision and/or rollover or pile up/mass collision) ~~of a transport system (a motor vehicle, a train or an aeroplane)~~ or during in-flight turbulence. ~~related vibrations of an aeroplane~~

2. Discussion of the Prior Art:

It is known in the prior art to provide for a passenger of a transport system an anti-submarining device in order to prevent severe/fatal injury in a rear-end collision.

~~— a three-point seat belt (safety belt or lap-shoulder seat belt assembly), mounted in the motor vehicle, consisting of a shoulder belt extending across the upper part of his body and of a lap belt extending across the lower part of his body; or~~

~~— a two-point seat belt, mounted in the aeroplane, acting as lap belt extending across the lower part of his body; or~~

~~— a suspender- (waist-) belt consisting of several pieces (belt-members).~~

In order to formulate in single terminology a generalized definition is presented for the proper term:

Definition:	**Proper Term:**
"Stiff first transport-system member"	Floor **6** of the transport system adjacent to a first seat-side SR (**Fig.** 1) or seat-cushion frame at the first seat-side or mid-tunnel (not drawn) of the motor vehicle adjacent to the first seat-side.
"Stiff second transport-system member"	Floor **6** of the transport system adjacent to a second seat-side SL or seat-cushion frame at the second seat-side or post section (not drawn) of the motor vehicle adjacent to the second seat-side or side rail of the motor vehicle adjacent to the second seat-side

"Seat frame" Seat-cushion frame or seat-backrest frame

~~It is well known to provide different restraint systems in vehicles, predominantly, three-point seat belts in various types for seats, exemplified by DE 37 41 831 A1 shown in Fig. 11.~~ In order to prevent whiplash front seats of SAAB 9-5 cars are equipped with active head restraints (rests) that, each activated by the mass inertia force of the upper part of the body (torso) in rear-end collisions, move up and closer to head of the front-seated occupant. See shortcomings, undermentioned.

In collaboration with Autoliv Corp., the biggest car-supplier in the world, Volvo Corp. has developed WHIPS (Whiplash Injury Prevention System), installed in the front seats of Volvo S80s. Under load of mass inertia forces of a passenger's torso in a rear-end collision the hinge of the seat backrest yields and partially rotates backwards and downwards to facilitate the head rest to intercept the head and the seat backrest, filled with pads, to absorb forces. When a car crashes into the rear section of a S80 and both catch fire, the front-seated passengers and their seat backrests, rotated backwards and downwards, impede the evacuation of the back-seated passengers, who may be severely injured. The front-seated passengers must sit up in order to take further action. Taken as given, the rotated seat backrests cannot be returned to the home position precious time elapses to step out of the car. This raises the question of how the front-seated, back-seated passengers and/or back-seated children, exposed to explosion, burn and/or toxic smoke, can evacuate themselves out of Volvo S80 and V70, both catching fire while travelling on roads, and/or how rescue workers can evacuate all the severely injured back-seated passengers. The report "U160704" of burnt Volvo S80 and V70 is incorporated herein.

Due to lack of space, in which the SAAB and Volvo protective devices should be installed, heads of back-seated passengers are unprotected, hence, subjected to whiplash and severe/fatal injury resulting from submarining. For sure, both protective devices remain ineffective in a multi-crash when the front-seated passengers, being submarining underneath their respective lap belt portions, is crushed into death by the airbags, deployed in the front-end crash or falsely deployed in the rear-end crash.

Exemplified in DE 43 36 351 A1 (US serial no. 979,938), a pan, moveable along a pair of rails beneath the seat cushion, is activated in a rear-end collision and moved out therefrom to intercept a passenger when submarining and falling down therefrom. Ref. to EP 0 403 072 A2 (US serial no. 364,765) a pair of U-shaped ramps is built in a rear seat. Each ramp comprises two longitudinal members, both fastened to the vehicle floor, and a lateral member, which, arranged along the front portion of the rear seat, intercepts a submarining passenger in a rear-end collision.
Both anti-submarining devices can never prevent severe/fatal injuries linked to great belt force, deployed or falsely deployed airbags, different weights and/or different body proportions.

When a Ford Mondeo, swerving on a road outside the city Idstein, crashes twice into a barrier and finally into a bus, the face of an obese female driver, submarining, is fractured and crushed by the airbag into her skull. In the real-world multi-front-end collision at far higher speed and strong yaw-acceleration great rotatory- and longitudinal-acceleration dependant forces (**Figs.** 4, 5) enormously elongate the lap belt portion underneath which the belted passenger submarines in the direction „L_y" or „Z_E" (**Figs.** 4 and 7) due to the limitation of the belt pretensioner which can only retract the seat belt up to 30 cm. The accident report

"U260901" is incorporated herein. All the anti-submarining devices, above-mentioned, can never prevent obese passengers from submarining when their car is involved in a real-world multi-front-end collision.

Any belted passenger, lying in a sleeping position ref. to DE 37 41 831 C2 (**Fig. 7**), submarines when being loaded by great mass inertia force „S_y" in the direction „Z_E" in the event of accident.

US 3,977,696 discloses a four-point seat belt, comprising a three-point seat belt and an upper shoulder belt, both of which, provided with belt retractors, are guided in two rails and driven by electrical motors of a heavy device. When the vehicle roof is totally deformed in a rollover-accident the heavy device crushes the passengers into death.

US 5,123,673 discloses a four-point seat belt, comprising a three-point seat belt and an upper shoulder belt, both of which are provided with belt retractors. An intricate, automatic release device facilitates the release of both buckle assemblies, each equipped with an actuator to release them, regardless of which one is manually released first. When an MB 200 crashes into the vehicle door of an MB S in the city of Geisenheim, a lateral intrusion of about 80 cm is measured. The accident report "U170199" is incorporated herein. When used, the buckle assembly, actuator and other parts, all of which face the totally deformed vehicle door, are destroyed. Hence, the other one does not function. The severely injured driver remains restrained. This rescue workers can't evacuate him within seconds.
In the NHSTA side crash test, which, currently legislated, idealizes an SUV crashing at an angle of 30^0 into a door or vehicle side, the buckle assembly, actuator and other parts are destroyed.
A complicated latch-plate-feeding device, installed to the side of seat cushion, moves forwards to present the latch plate of the three-point seat belt to the passenger, after having sat down. This device, facing the vehicle door totally deformed in a side crash, is destroyed.

US 5,641,200 discloses a child restraint seat for securing a child in a shopping cart, provided with a seat cushion and backrest on which the child is seated. A pair of shoulder belts, fastened at the mid portions to the seat backrest, has two pairs of end portions which, equipped with a pair of belt connectors, consisting of tabs and receptacles, extend across in an X-shape over the child, being restrained when the tabs are inserted into the respective receptacles.

Harness restraint systems ref. to US 4,231,616, US 4,402,548, US 5,131,683, US 5,524,928, US 6,139,111, US 6,179,329 B1 and US 6,705,641 B2 are well-known as suspender belts. Each belt portion of the suspender belt or each belt must always be adjusted to an appropriate length depending on the size of the passenger as well as on what he is wearing. All these suspender belts have the following drawbacks:

D1. In general, suspender belts are not popular because finding all the belt portions and connecting all the attachment ends to the release device is a lengthy process, especially in the dark. Moreover, all the belt portions make an untidy impression and are not beneficial for sales.

D2. Exemplified in US 6,139,111, all four belts are retracted to different lengths and blocked by the four respective pretension retractors within different time frames in milliseconds in an accident. It doesn't work. Each five-person car additionally needs 15 pretension retractors. No car corporation will waste money for additional pretension retractors installed in millions of motor vehicles produced annually.

D3. Under the load of the same belt force in a front collision the deformation of the seat backrest, wherein both belt ends are fastened, is larger, thus increasing the forward motion.

D4. The biggest drawback is the failure of the restraint. When the belt force exceeds 24,000 N due to lack of energy absorbers in real-world accidents the passengers are severely/fatally injured. Moreover, the restraint fails because the belt elongates at a force-dependant rate over 25 %, shown in **Fig.** 6 of PCT/US99/13362 (US 09/098,294). A belted heavy driver of AUDI A6 freed himself out of the restraint in a rollover accident. The accident report "U281202" is incorporated herein.

Despite being properly restrained and properly seated on a child-seat, perfectly secured to the rear seat, a six-year old child, freeing himself out of the restraint, was ejected out of a Toyota Yaris, travelling at 100 km/h, when laterally slamming into a concrete wall. The accident report "U211002" is incorporated herein.

Ref. to **Figs.** 8 and 9 of US 5,524,928 the harness restraint system is defined by

a) two shoulder belts 12, 14, each equipped with a belt retractor 20 (see **D2**),

b) a pair of lap belts 46, fastened to the vehicle floor and equipped with eyelets 44 loosely connected to both shoulder belts, and

c) a Y-shaped connector 26, comprising

- a first web 26a fastened to the shoulder belt 14,
- a second web 26b, serving as a buckle assembly having a release button 34 to be plug-in connected to a latch plate 32b (not drawn) of shoulder belt 12, and
- a third web 26c, serving as a buckle assembly having a release button 28 to be plug-in connected to a latch plate 32c (not drawn), fastened to one end of an anti-submarining belt 24, projected through a sleeve 50 of the seat 16 and the other end of which is fastened to the vehicle floor.

This restraint system, characterized by the drawbacks **D1 to D4**, has the following drawbacks:

D5. When the lap belts 46 with fixed length are laid out for, say, skinny, 1.5 metre tall Asians, obese, over 2 metre tall passengers cannot use the restraint systems at all. Due to the failure of the principle feature to protect various sizes of the passengers from submarining no agencies world-wide give approval to motor vehicles, equipped therewith, thus resulting in bankruptcy of the car corp.

D6. Because all three belts 24, 46 have fixed lengths the seat can neither be moved in any direction, particularly in the furthest forward or rearward position, nor be tilted in different sloping seat-positions nor can the passenger remain restrained in any seat-position. Due to the failure of the principle feature to co-operate with seat-adjusting mechanisms nobody buys motor vehicles, equipped therewith, thus resulting in bankruptcy of the car corp.

D7. Given, all five belts are equipped with belt retractors and pretensioners, skinny and normal passengers 18A, 18 would be „protected" against submarining when the latch plate 32c is plug-in connected to the third web 26c. For sure, passengers 18A, 18, restrained in slack mode, under great submarining force „S_y" (**Fig.** 7) are forced into the stiff, Y-shaped connectors 26 and are severely/fatally injured or castrated, if they are male! In addition thereto, the respective airbags crush the heads of the passengers, while submarining, into the seat backrests. See the accident report "U260901". Compensatory damages of millions of dollars are due.

D8. Crotch pads 160, designed to absorb submarining energy and each placed in between the crotch and the hole of sleeve 50, in different sizes must be designed for passengers from skinny to obese size! Putting them into use consumes time.

D9. When an obese passenger 18B takes his seat, he, covering the hole of sleeve 50, can never be restrained to prevent submarining. Hence, this feature discriminates against 51 million obese US-adults, 30 million obese Chinese children and millions of obese Asians, Europeans and Canadians! The accident report "OBESITY" for the EU, NHSTA, NTSB, FAA and Canadian Transport is incorporated herein.

D10. The belt user has to depress two release buttons 34, 28 to release the respective latch plates from the buckle assemblies 26b, 26c. This two-click operation causes discomfort and hinders rescue work. See one-click operation by depressing the master release button, mentioned below.

D11. Ford Corp. has recalled 1.4 million brand-new motor vehicles due to the unreliability of the plug-in connection of latch plate with buckle assembly, both of which are standard parts manufactured by the renown supplier TRW! The latch plate, when inserted into the buckle assembly and connected thereto, can be detached therefrom during normal use. The report by the German Newspaper „Frankfurter Allgemeine Zeitung" is incorporated herein. Y-shaped connectors 26 and energy-absorbing crotch pads 160 have to undergo lengthy, expensive testing and certification for reliability during normal use and in real-world accidents.

D12. The space underneath of the seat cushion 3.1, 3.1B of front or rear seat 3, 3B of a motor vehicle is exploited for a storage bin 15, 15B (**Figs.** 8 to 11) which, defined by three fixed side walls 15.1a, 15.2, 15.3, a front- or side opening door 15.4a, 15.4B, 15.4aB, a bottom bin-floor 15.6 and the seat cushion itself 3.1, 3.1B, is patented by the inventor and found in VW-, Renault- and Opel vans. The German Patent Doc. DE 196 55 051 C2 is incorporated herein. Due to the anti-submarining belt 24 eliminating the space for the storage bin, engineers of those car corporations must redesign vans without storage bins if this invention is put into use.

Of course, car corporations world-wide have no intention of taking the risk of going bankrupt resulting from lack of agencies' approval of cars, equipped with such harness restraint systems, the drawbacks **D1 to D12,** pouring billions of dollars into the tests, redesigning, recall actions, 20 additional belt retractors and pretensioners per five-person car, lawsuits and compensatory damages linked to severe/fatal injuries. Doubtless, only the features, listed herein, in co-operation with vibration-dampening energy absorbers are capable of resolving all these problems and others and the advantages thereof are obvious!

Ref. to US 4,231,616 a harness restraint system comprises a pair of belt deflectors, loosely connected to a pair of side attachment points at the seat-sides, an upper attachment point, located over the head, and a pair of length-adjustable belts, fastened together to the upper attachment point, projected through the belt deflectors and provided with a latch plate and buckle assembly at the respective distal ends.

Ref. to US 4,402,548 a safety seat comprises a shell-shaped seat, consisting of

a) a seat backrest, having
- a pair of lateral head-supporting pads,
- a pair of side portions and
- several pairs of anchorage slots on the back portion,

b) a seat cushion and

c) a harness restraint system, having

- a pair of length-adjustable shoulder belts, projected through the anchorage slots and fastened to attachment points at the side portions,
- a pair of length-adjustable lap belts, projected through a pair of anchorage slots and fastened to junctions between the pair of side portions and the seat cushion,
- an anti-submarining belt, projected through an anchorage slot of the seat cushion and fastened to the seat cushion, and
- a centrally positioned three-point release device, by which all five belts are interconnected.

Ref. to US 5,131,683 a harness restraint system comprises

a) a Y-shaped belt, consisting of a pair of shoulder belt portions, looping over the seat backrest and provided with two belt retractors fastened to the vehicle floor,

b) an abdomen belt portion, provided with a webbing ring,

c) a right lap belt, one end of which is fastened to the seat and the other, equipped with a latch plate, projecting through the webbing ring, and

d) a left lap belt, one end of which fastened to the seat and the other, equipped with a buckle assembly.

To buckle up an actress pulls the latch plate, positioned to the headrest, over her shoulder and the Y-shaped belt, damaging her hat and hair-style, over the upper part of her body. She misses the film festival.

Ref. to US 6,139,111 a harness restraint system comprises

a) a pair of shoulder belts, projecting through a head rest and connected to load-limiting belt retractors mounted on a cross member of the seat backrest,

b) a pair of leg belts, connected to pretension retractors mounted on a pair of seat rails,

c) a buckle assembly, to which the shoulder belt and lap belt are coupled, and

d) a latch plate, to which the other shoulder belt and lap belt are coupled.

Ref. to US 6,179,329 B1 a harness restraint system comprises a pair of length-adjustable shoulder belts, a neck belt, a pair of length-adjustable lap belts, an anti-submarining, length-adjustable belt and a conventional five-point release device, to which all the belts are connected. The manufacturing of each length-adjustable shoulder belt, defined by a lower and upper vertical belt, an abdomen- and a shoulder belt adjuster and other parts, is very intricate. The harness is attached to the seat at four attachment points. The top portions of shoulder belts, the neck belt and a neck strap cover are sewn together into a neck unit attached to the top attachment point by a neck belt component. The belted passenger is crippled under great yaw load due to the rupture of the neck belt component and the single top attachment point, incapable of sustaining the yaw load.

Ref. to US 6,705,641 B2 an inflatable harness restraint system comprises

a) a pair of inflatable shoulder belts, filled with inflatable members, such as gas or gas pellets, and extending over the upper part of the body of a passenger,

b) a pair of inflatable leg belts, filled with inflatable members, provided with belt retractors and restraining the lower part of the body,

c) a pair of anti-submarining belts, restraining the legs,

d) a buckle assembly, to which the inflatable shoulder belt, inflatable lap belt and anti-submarining belt are coupled, and

e) a latch plate, to which the other inflatable shoulder belt, inflatable lap belt and anti-submarining belt are coupled.

The explosion of one front airbag of VW Golf IV, reported by the television program "Plusminus" of German Broadcasting Station ARD on Sept. 21, 98, was measured at over 167 dB, exceeding the EU's threshold value of 140 dB, thus resulting in hearing damage or deafening. Dr. Beat W. Hohmann from Suva, a Swiss Accident Insurer in Lucerne, accomplished this test and a research work, in which the results, based on the theories, are validated by the test data. His test report is incorporated herein.

Due to the burning of faces and/or hands by hot gases leaking from the airbags, a US-court imposed a fine of $ 123.6 millions on Daimler Chrysler. In a front collision in Rotterdam a female driver of Volvo suffered face-burns of first and second degree. When a VW bus collided into the left front fender of a 6-day old, € 98,000 expensive MB SL 500, both at 30 km/h cruising speed in the city Geisenheim according to the MB driver, the airbags inflicted burns of first to third degree on the MB driver and co-driver and the seat belt squeezed the bosom of the MB co-driver. The accident report „DC" is incorporated herein.

If this inflatable harness restraint system, when inflated, inflicts deafening, injury and/or burns of first to third degree on an American, compensatory damages of three-figure millions of dollars are due.

In view of foregoing shortcomings, injuries and deficiencies, there is a need to ensure the restraint of any passenger as well as the operation of the anti-submarining devices in any accident.

~~It is well known to provide different restraint systems in vehicles, predominantly, three-point seat belts in various types for seats, exemplified by DE 37 41 831 A1 shown in **Fig.** 11. Evidently, when both shoulders of a passenger, conventionally belted, are not restrained in the event of an arbitrary collision with another vehicle in any direction, shown in **Figs.** 3, 4 and 7, the unrestrained shoulder can always move and/or rotate freely, thereby resulting in severe/fatal injuries in real-world accidents when~~

~~— the head crashes into the steering wheel and/or window pane and/or~~

~~— the airbag crushes the head, which, loaded by the forces related to pitch-acceleration $\ddot{U}_H$, yaw-acceleration Ö, longitudinal and/or lateral-acceleration, is in "oop" (out of position).~~

~~Moreover, by the definition of „submarining" the belted passenger submarines (slips downward) under his seat belt thus negating the protective effect of the seat belt.~~

~~It is well known to provide two-point or lap seat belts for aeroplane seats as well as mid-portion of the rear seats of motor vehicles. This lap seat belt is far less effective than a three-point seat belt. Due to very large accelerations during a turbulence-related flight the protective effect is very low.~~

~~A substantially improved protection is proposed by two different configurations of a one-piece seat belt, exemplified by DE 26 02 875 A1 (**Figs.** 8 to 10). An „X-shaped" restraint is arranged by extending both shoulder belts crosswise over the upper part of body while the lower part of body is restrained by the lap belt. Each end of the one-piece seat belt is connected to a belt retractor, fastened in the seat backrest. Two grab rings, positioned to the headrest, move along the belt. A single or double „X-shaped" configuration is defined by pulling a pair of grab rings and belt portions over the head, shoulders and head rest and engaging them in the corresponding hooks. Due to such intricate operation the seat belt remains unused.~~

~~According to US 3,977,696, US 5,123,673, US 5,411,319, DE-OS 23 45 847, DE-OS 28 13 888 and DE 196 29 878 A1 the restraint system comprises a three-point seat belt, a second shoulder belt and two belt retractors, responsible for retracting both belts. The „X-~~

~~shaped" configuration, formed by extending both belts crosswise over the upper part of the body, has the following drawbacks in the event of an accident:~~

~~**D1**. Both belts are retracted to different length by two independently operating belt retractors within milliseconds.~~

~~**D2**. Under the load of the same belt force in a front collision the deformation of seat backrest, wherein both belt ends are fastened, is larger, thus increasing the forward motion. Furthermore, it is impossible to attach an energy absorber because all four belt ends are occupied.~~

~~A one-piece seat belt **1** (**Fig.** 1) ref. to DE-OS 28 13 888 is equipped with two belt retractors (not drawn), fastened to both belt ends in the seat backrest, and a belt deflector **17**, anchored to the seat frame **3.3** of the mid-portion of rear seat. The feature, proposed for a child, has the following drawbacks:~~

~~**D3**. When the release button **84** is depressed, the belt portion **1.1** gets entangled around the neck of passenger. For the operation of restraining and extending both belt portions into the „X-shaped" configuration, the passenger must lower his head first.~~

~~**D4**. Because all belt ends are occupied, it is impossible to attach energy absorbers and to adjust the belt to the size of an upper part of body **95** of an adult.~~

~~Generally, a child-seat is fastened by four auxiliary belts to the seat. Despite the „X-shaped" configuration of a one-piece seat belt to restrain a child, sitting in a child-seat, ref. to FR 2 342 872 A1 the problems, associated with the retraction of four auxiliary belts, submarining and energy absorption, remain unsolved in an accident.~~

~~Till now, trains, school buses and buses are not provided with restraint systems.~~

SUMMARY OF THE INVENTION

Accordingly, the principle object of the present invention is to provide for passengers of a transport system anti-submarining seat-belt assemblies which resolve all the above-mentioned shortcomings and deficiencies, prevent submarining and injuries, absorb impact energy and dampen vibration in the event of an accident or during in-flight turbulence and are suited for two-, three- and multi-point seat belts.

~~seat belts, each, equipped with a belt retractor, solely responsible for retraction, blocking and tightening or for protraction, a lower belt deflector to loosely guide a belt portion and multi-attachment points (multi-points of restraint), restrains a passenger in multi-attachment points, in order to lower and distribute the acceleration-dependent loads, shown in **Fig.** 3 and **Tables** 1 to 3, to the multi-attachment points in the event of any accident thereof or turbulence-related vibrations of an aeroplane. Nowadays, belt tighteners are incorporated into belt retractors, for example, of MB 500 SL in order to save costs, assembling time and space.~~ A second object of the present invention resides in ~~a user-friendly belt-feeding device to ease the restraint and in~~ one-click operation by means of a master release button, when depressed, to release the main and anti-submarining ~~all~~ latch plates from the respective buckle assemblies ~~and/or return the belt-feeding device to the home position~~. In emergency cases paramedics and fire-fighters can easily rescue the injured passengers.

A third object of the present invention resides in a cost-saving method of concealing a Vehicle Identification Number from car thieves and a cost-, space-saving integration of ~~the~~ a multi-point seat belt, equipped with vibration-dampening energy absorbers, the anti-submarining seat-belt assembly and the seat into a safety seat, which can be converted into a baby-cot, child-seat or ~~safety~~ adult seat and vice-versa, illustrated in **Figs.** 1, ~~2~~3~~5~~.

INDUSTRIAL APPLICABILITY

It should be apparent that the invention provides ~~a~~ substantially improved restraint including the following features:

a) The survival chance is enhanced by the restraint of
   * both shoulders and the torso, when the passenger is thrown forward (~~**Fig. 4, Table** 3~~) and/or subjected to the yaw Ö-acceleration-dependent torque „$T_{ö}$", and
   * both thighs and the lower part of the ~~part of the~~ body, when the passenger submarines.

b) ~~Because the belt retractor is attached to one belt end, a~~ A number of sets of vibration-dampening energy absorbers ref. to US serial no. 09/554,464 (WO 99/24292, ~~(~~PCT/DE98/03271, European Patent EP 1 037 771 B1, German Patent DE 197 58 498 C2~~, pending US~~ and CA pending patent 2,314,345) or German Patent DE 197 58 497 C2 can be attached to coupling fittings of anti-submarining seat belt assemblies ~~the other belt end~~ (**Figs.** ~~1~~23a, ~~1~~23b, ~~18~~3c). Hence,~~, thus gradually absorbing~~ large impact energy can be gradually absorbed below the respective injury-related values. Several sets of vibration-dampening energy absorbers can be attached to a length-adjustable belt of the anti-submarining seat belt assembly **8b, 8c (Fig.** 1). The inventor of the present application has submitted those patent documents and applications to CIPO as well as USPTO. The vibration-dampening energy absorber consists of a number of clamping elements, having sites of predetermined fracture, and a retaining element, which, fastened to the seat backrest frame and/or seat frame, can serve as an integral part thereof. When the clamping elements, biased on the retaining element, under great belt force move therealong vibration is dampened by friction.

c) Owing to the different positions of anti-submarining buckle assemblies, in plug-in connection with the respective anti-submarining latch plates, passengers of different body proportions, thighs and weight can adjust the length of the anti-submarining belt portions **1.3R, 1.3L** ~~belts~~ by themselves. Moreover, the adult seats, equipped therewith, ~~for adults~~ can be modified for children and vice versa, thus ~~augmenting~~ increasing the rate of seat occupancy in a bus, train or an aeroplane, exemplified in **Fig.** ~~23~~5. In another embodiment the length-adjustable belt of the anti-submarining seat belt assembly **8b, 8c** facilitates, for example, a female passenger to adapt the belt length to her long gown or to herself, when lying in sleeping position (**Figs.** 1, 7).

~~b) In another embodiment an upper belt deflector **5b** (**Fig.** 15), in plug-in connection with the buckle assembly **4**, or the buckle assembly **4** is height-adjustable. Energy absorbers, above-mentioned, can be connected to this buckle assembly. Upon the use of the height-adjustable belt deflector **5b** the height-adjustable D-ring **12**, attached to the B-, C-, D-post section (pillar, pillar portion), shown in **Fig.** 1, or to the top edge of the seat backrest, is no longer needed. When the belt deflector **5b** is not height-adjustable, it can be connected to energy absorbers which absorb energy and dampen vibration when the first shoulder belt portion moves it up.~~

~~c) In another embodiment the upper belt deflector **5a** (**Fig.** 13) can be rigidly attached to the head rest **3.6a**. Any adjustment of the height of the head rest **3.6a** to the head automatically adjusts the height of the upper belt deflector to the shoulder. This feature differs from the D-ring ref. to DE 40 10 452 A1, which is in contact with the shoulder~~

~~belt, when the passenger is thrown forward, and is moved up to intercept the head, when thrown backward.~~

d) For safety reasons and easy access the anti-submarining latch plates **11, 25**, when not being used, are stored in a storage box **25.5** (**Fig.** 5). The belt-detachable anti-submarining latch plates **25** (**Fig.** 2) are attached to the lap belt portion when needed.

~~i)~~e)For the convenience of the passenger, when stepping out, or for a ~~quick-~~ fast rescue of the passenger injured~~, when being rescued~~ in an accidents, the master release button **84** of the buckle assembly **9.1** is depressed to release all latch plates from the buckle assemblies~~and/or to return the belt feeding device to the resting (home) position~~.

~~f) The round rollover tubes **20.2b** of the seat backrest frame **3.4d** are designed to guide the belt housing **20.4c, 20.4d** (**Figs.** 18, 19), to act as safety bars in a rollover and to allow free view to the rear owing to openings **97R, 97L** (**Fig.** 23).~~

~~g) In another embodiment the seat belt can be connected to the seat in more than three attachment points (**Figs.** 1, 14, 23), in which both thighs (femurs) are restrained, thus protecting the passenger from submarining in a front, rear collision or rollover or when in sleeping position. Unlike the suspender (waist-) belt, consisting of several belts, the portions of multi-point seat belt need not be adjusted in length, when the circumference of the passenger varies depending on the clothes worn.~~

BRIEF DESCRIPTION OF THE DRAWINGS

A number of embodiments, other advantages and features of the present invention will be described in the accompanying tables and drawings with reference to the xyz global coordinate system:

Table 1 shows test data such as left / right thigh-force, belt force and pitch-angle of driver and co-driver in 50% offset crash test of several European vehicles at crash speed of 55 km/h.

Table 2 shows yaw angle O of driver / co-driver in a 50% offset crash tests.

Table 3 shows test data of the safest child-restraint system Chico Shuttle® at the converted velocity of 55 km/h in comparison with the safest vehicle among them listed in **Table** 1.

Fig. 1 is a perspective view of a seat with upper buckle assemblies and anti-submarining buckle assemblies **7, 8, 8a to 8d**, attached to the seat backrest and seat cushion, as well as of a ~~the 1st embodiment of~~ restraint system consisting of a multi-point seat belt **1**, latch plate **11** along the lap belt, shoulder latch plate **2** of belt end, in the direction of arrow „Z" in plug-in connection with an upper buckle assembly **4**, and a seat belt in X-shape, formed by crossing both shoulder belt portions **1.1, 1.2**.

Fig. ~~1~~62 is a schematic view of a detachable anti-submarining latch plate **25**~~the 2nd and 3rd embodiment of spatially adjusting belt feeding devices **20a and 20b** in kinematics from the operating position to the resting position in x-y plane~~.

Fig. ~~12~~3a is a schematic, perspective view of ~~the~~a ~~1st~~ 1st embodiment of a buckle assembly **4a**, equipped with a release cable **4.2**.

Fig. ~~12~~3b is a schematic, perspective view of ~~the~~a ~~2nd~~ 2nd embodiment of a buckle assembly **4b**, equipped with an electrical release-motor **4.2b**.

Fig. ~~2~~13c is a schematic, perspective view of a 3rd embodiment of a buckle assembly **4c**, equipped with a release cable **4.3**. ~~a cross-sectional view of the height- and width-adjusting mechanism **27** along the line II-II of **Fig.** 20.~~

Fig. ~~14~~4 is a perspective view of a anti-submarining latch plate **11** of a lap belt portion **1.3** in plug-in connection with ~~a~~the anti-submarining buckle assembly **8 and of the 1st embodiment of a belt feeding device 20 of the seat belt**.

Fig. ~~23~~5 is a front view of the seat **3a to 3d**, in which the restraint systems **1a to 1d**, anti-submarining seat-belt assemblies and storage boxes **25.5** are integrated, for passengers of different weights, different circumference of thighs and different body proportions (sizes), where anti-submarining buckle assemblies are in plug-in connection with the anti-submarining latch plates **11, 25**.

Fig. 6 illustrates two curves of strain/elongation rate dependent from force ref. to PCT/US99/13362 (US 09/098,294).

Fig. ~~11~~7 is a top view of a ∠- shaped seat belt ref. to DE 37 41 831 A1, where a belted passenger, in sleeping position, under load of great mass inertia force „S_y" in the direction „Z_E" submarines.

Fig. 8 is a front view of a fixed seat equipped with a harness restraint system ref. to US 5,524,928.

Fig. 9 is a side view of the fixed seat equipped with the harness restraint system ref. to US 5,524,928.

Fig. 10 is a perspective view of a seat, moveable along a pair of floor rail assemblies equipped with a storage bin 15 ref. to DE 196 55 051 C2.

Fig. 11 is a perspective view of a fixed seat equipped with another storage bin 15B ref. to DE 196 55 051 C2.

Fig. 12 is a side view of a 1st embodiment of a property of limited ~~absorbing~~ energy absorption **70** of the seat belt **1** or a length-adjustable belt **8.1** and of a „VIN" **81**.

Fig. 13 is a side view of a 2nd embodiment of a property of limited ~~absorbing~~ energy absorption **80** of the seat belt **1** or a length-adjustable belt **8.1** and of the „VIN" **81**.

Fig. 14 is a top view of the 2nd embodiment of the property of limited ~~absorbing~~ energy absorption **80** of the seat belt **1** or the length-adjustable belt **8.1**.

~~**Fig.** 2 is a perspective view of a seat and of the 2nd embodiment of a restraint system comprising three-point seat belt **1c** having a transition latch plate 2, which will be inserted into a transition buckle assembly **4c** of a shoulder belt **1.11**, pulled in the direction of arrow „Z".~~

~~**Fig.** 3 illustrates load cases I, II and III in z-y plane in the event of a real-world accident.~~

~~**Fig.** 4 is a perspective view of a restrained dummy thrown forward in VW Polo® in a 50% offset crash test.~~

~~**Fig.** 5 illustrates a yaw-acceleration Ö and yaw-angle O of a vehicle about the vertical axis „z_A" in a 50% offset crash test of two identical vehicles.~~

~~**Fig.** 6 illustrates a yaw angle O of vehicle about the vertical axis „z_A" in a 50% offset crash test into a stiff barrier.~~

~~**Fig.** 7 illustrates four collision types „U1" to „U4" ref. to the research work of Institute of Vehicle Safety, a Dept. of German Insurers Association.~~

~~**Fig.** 8 is a front view of a seat belt ref. to DE-OS 26 02 875 in home position.~~

~~**Fig.** 9 is a front view of a double X-shaped seat belt ref. to DE-OS 26 02 875.~~

~~**Fig.** 10 is a front view of a single X-shaped seat belt ref. to DE-OS 26 02 875.~~

~~**Fig.** 13 is a perspective view of an upper belt deflector of the head rest.~~

~~**Fig.** 15 is a perspective view of the 2nd embodiment of a spatially adjusting belt feeding device **20a** from the resting position to the operating position and of a height-adjustable belt deflector **5b**.~~

~~**Figs.** 17a to 17f are schematic, perspective views of the belt feeding device **20** in kinematics from the resting position to the operating position.~~

~~**Fig.** 18 is a schematic, perspective view of a seat, equipped with the rollover tubes **20.2b**, and of the 4th embodiment of a belt feeding device **20c**.~~

~~**Fig.** 19 is a schematic, perspective view of a seat having the rollover tubes **20.2b**, the 5th embodiment of a belt feeding device **20d**, provided with a safety bracket **20.6**, a height and width adjusting mechanism **27, 27a**.~~

~~**Fig.** 20 is a cross sectional view of the 1st embodiment of the height and width adjusting mechanism **27** along the line I-I of **Fig.** 19.~~

~~**Fig.** 22 cross sectional view of the 2nd embodiment of the height and width adjusting mechanism **27a** along the line I-I of **Fig.** 19.~~

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The advantages of the preferred embodiments in the Chap. "INDUSTRIAL APPLICABILITY" are outlined hereinafter with regard to the functions and features thereof.

Just at a crash speed of 55 km/h the belt force of a driver of the premium car AUDI A8 is measured 9,130 N (**Table** 1) equivalent to 2,015 pound by which the seat belt is elongated (strained) about 19 % (**Fig.** 6). The elongation ranges from 47.5 to 57 cm when the seat belt is 2.5 to 3 m long. In case the belt pretensioner remains inoperative and, in particular, the total mass inertia force „S_y" of the lower part of the body of the passenger is far larger than that of the upper part thereof his body slips (submarines) underneath the lap belt portion in a real-world accident. The method of the present invention capitalizes on the premise that a lap ~~seat~~ belt portion, ~~is employed to~~ restraining a lower part of the body of the belted passenger, is subdivided into two anti-submarining belt portions **1.3R, 1.3L** which properly restrain as well as hold his thighs when plug-in connecting at least one anti-submarining latch plate **11, 25** to the respective one of anti-submarining buckle assemblies **7, 8, 8a to 8d (Figs.** 1, 4 and 5), all of which are equipped with vibration-dampening energy absorbers. As a result, the anti-submarining seat-belt assembly in association with vibration-dampening energy absorbers

- substantially lowers large belt force, for example, of 15,190 N at only 55 km/h (**Table** 1), in a real-world accident or during in-flight turbulence,
- prevents large elongation of the seat belt webbing, severe/fatal injury and the passenger of a Mercedes Car, lying in the sleeping position (**Fig.** 7), from submarining and
- ensures the operation of the active head restraint of SAAB 9-5 and
- resolves all the drawbacks of Volvo's WHIPS and the prior art.

~~in at least four attachment points of the seat to distribute all acceleration dependant loads, particularly the yaw Ö acceleration dependent torque $T_ö$, thereto in an accident, thus ensuring the operation of a single belt retractor to pre tension (bias) as well as tension the belt, restraining both shoulders, upper and lower part of the body and lowering all the loads, in particular, in co operation with the energy absorption when a number of sets of energy absorbers is put into use. This will be apparent when all forces, imposed on the belted passenger, shown in **Figs.** 3 and 4, are formulated in the event of a front collision, where the loads of the mass D_S of the torso are lowered because~~

~~— the forward motion „w," is minimized, thus substantially reducing the pitch acceleration $Ü_H$ and force F_{H_y} of the mass D_H of the head, and~~

~~the yaw-acceleration Ö is minimized, thus substantially reducing the torque $T_ö$, imposed on the head. Great torque $T_ö$ is the most latent force, responsible for sudden death. To a great extent massive head injuries can be avoided.~~

~~Load case I in z-y plane: The rotating mass D_S rotates about the rotating axis „S" at the pitch-angle U_S and mass D_H about the rotating axis „z" at the pitch-angle U_H in **Table** 1, thereby resulting in the pitch-accelerations $Ü_S$, $Ü_H$ and rotating forces F_{Sy}, F_{Hy}. The addition of both rotating forces yields the force F_V linked to the forward motion w_V of passenger, shown in **Fig.** 4.~~

~~In front- and/or rear-collision the passenger is exposed to the submarining force S_y, shown in **Fig.** 14.~~

~~Load case II in x-y plane: The upper part of body is subjected to the torque $T_ö$, exerted by the yaw-acceleration Ö about the rotating axis „z". When the upper part is restrained in an X-shape, the torque is substituted by a pair of forces.~~

~~Load case III in x-z plane: The rotating mass D_S rotates about the rotating axis „S" at the rotating angle U_y and mass D_H about the rotating axis „z" at the rotating angle U_{Hy}, thereby resulting in the rotating accelerations $Ü_y$, $Ü_{Hy}$ and rotating forces D_{Sy}, D_{Hy} (not drawn). In a rollover the passenger is subjected to the load F_{Sz}.~~

~~Load case IV: In turbulence-related vibrations of an aeroplane the load D_{Sy} together with D_{Hy} takes the form of periodical load $\pm F_{Hx}$, F_{Sz} of $\pm F_{Sz}$, $T_ö$ of $\pm T_ö$, S_y of $\pm S_y$ and F_{Sy} together with F_{Hy} of $\pm F_V$.~~

~~The restraint system, illustrated in **Fig.** 1, is provided with a conventional belt retractor **13** having a clamping device, housed in the B-, C-, D-post section or in one of both sides SL and SR of a seat backrest **3.2** and connected to the belt end EL. The other belt end ER is provided with a shoulder latch plate **2**, which is retained, loosely guided by a lower belt deflector **17**, fastened to the vehicle floor, and inserted into one of the buckle assemblies **4, 4a to 4c, 14, 14a, 18, 18a, 18b**, arranged in or to the seat backrest **3.2**. In all embodiments an additional latch plate **9** can move along the seat belt **1** between both belt ends EL and ER. When plug-in connecting the shoulder latch plate **2** (in the direction of arrow "Z") to the buckle assembly **4** and the latch plate **9** to the buckle assembly **9.1**, an X-shaped restraint of the upper part of body and both shoulders as well as a restraint of the lower part of body are accomplished by both belt portions **1.1, 1.2** and the lap belt portion **1.3**.~~

~~In the 2nd embodiment, shown in **Fig.** 2, a transition product, comprising conventional three-point seat belt **1c** and new parts, has to be invented due to the delay resulting from the production of multi-point seat belts **1**. The floor fitting (not shown) is replaced by lower belt deflector **17**. The end of the lower shoulder belt portion **1.11** is provided with transition latch plate **2**. The end of an upper shoulder belt **1.12** and the other end are equipped with a transition buckle assembly **4c**, having release button **84c**, and with a second belt retractor **13a**, arranged in the seat backrest **3.2**. The restraint in an X-shape is defined by plug-in connection of transition latch plate **2** with the transition buckle assembly **4c**. In order to resolve the above-mentioned drawback **D1**, the spring force of the second belt retractor **13a**, to retract the shoulder belt **1.12** on depressing the release button **84c**, is far less than of the belt retractor **13**. Despite the circumference of the restrained passenger, varying depending on the clothes worn, and the different seat position the shoulder belt portion **1.11** always projects through the lower belt deflector **17** at a sufficient length of "l_1" in order to maintain~~

~~the function of the belt retractor **13** to retract, to block the belt as well as to release the retracted belt during the travel and the function of the belt tightener (not drawn), incorporated in the belt retractor, to forcefully retract (withdraw) and tighten the belt in an accident.~~ In an embodiment t~~T~~he release button **84ef, 84e** of free-moving ~~transition~~ anti-submarining buckle assembly **4e8b, 8c (Fig. 1)**, whose housing is free-moving on the seat cushion and whose length-adjustable belt is fastened ~~arranged~~ to ~~or in~~ the seat frame, can be controlled neither by a release cable **4.2** nor by an electrical release-motor **4.2b**. Hence, the release button **84ee, 84f** can only be activated by an electrical signals emitted from ~~when depressing~~ the master release button **84**, when depressed, to remove the protection from submarining.

~~The other end of shoulder belt **1.12** can be connected either to a coupling fitting **1.2a, 1.2b** (**Figs.** 12a, 12b, 18, 19) or to the belt retractor **13a** (belt retractor **13** shown in **Fig.** 18) having a coupling fitting **1.2b** in order to receive a number of energy absorbers to dissipate great impact energy and dampen strong vibration.~~

~~In another embodiment the shoulder belt **1.12a** consists of the transition buckle assembly **4c** and a shoulder latch plate **2a** (not shown), similar to latch plate **2**, which is plug-in connected to~~

~~— the upper buckle assembly **4, 4a to 4c, 14, 14a, 18, 18a, 18b, 18.1 to 18.3**, arranged in the seat backrest, in operation position or~~

~~— the assisting buckle assembly **16, 16a, 16b** in resting position.~~

~~When motor vehicles are already licensed, modification of different seats and three-point seat belts can easily be accomplished by arrangement of at least one buckle assembly, of the lower belt deflector **17**, of the second belt retractor **13a** and by collection of one-piece, detachable shoulder belts **1.12a** with different length. Furthermore, the latch plate **2a** can be detached from the buckle assembly by depressing the master release button **84**.~~

~~A first shoulder belt portion **1.1** is defined by the upper shoulder belt **1.12, 1.12a** and the lower shoulder belt portion **1.11**.~~

~~At an expensive modification or at new transport system the use of belt-feeding device **20, 20a to 20d** enhances the convenience and comfort, where the shoulder belt **1.12, 1.12a** having transition buckle assembly **4c** is a part thereof.~~

~~Evidently, the three-point seat belt **1c** in plug-in connection with the shoulder belt **1.12, 1.12a** serves as a transition solution for the multi-point seat belt **1, 1a to 1d** during the production.~~

~~In the above-mentioned embodiments to resolve the above-mentioned drawback **D3** the upper part of body is restrained by extending the shoulder belt portions crosswise in an X-shape~~

~~c1) when at least one latch plate **2** is plug-in connected to the buckle assembly of the seat backrest; *or*~~

~~c2) when a latch plate **2**, arranged to the end ER of the first shoulder belt portion **1.1** of a belt-feeding device **20a, 20b**, is plug-in connected to the buckle assembly of the seat backrest; *or*~~

~~c3) when the belt-feeding device **20, 20c, 20d** positions the first shoulder belt portion **1.1**, the belt end ER of which is arranged to or in the side SR of the seat backrest, from the operation position to a resting position.~~

~~These features c2) and c3) have the advantage that the common practise to operate the conventional three-point seat belt is preserved.~~

~~In order to resolve the above-mentioned drawbacks **D2** and **D4** great energy is absorbed and strong vibration is dampened by a large number of energy absorbers connected to the respective buckle assemblies **4, 4a to 4c, 4c, 7, 8, 8a to 8d, 9.1, 14, 14a, 15, 15a, 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3** (**Figs.** 1, 14, 19, 23) into which latch plates are inserted.~~

~~As shown in **Figs.** 1 and 14, the seat belt **1** is equipped with an anti-submarining latch plate **11**, which can be connected to one of the buckle assemblies **7, 8, 8a to 8d**, arranged in or to the seat frame **3.3**. When plug-in connected, the lap belt portion **1.3** is subdivided into two belt portions **1.3R, 1.3L**. Owing to the restraint of both thighs the submarining problem in front- or rear collision, in rollover or turbulence-related vibration of an aeroplane is resolved. Moreover, the passenger, lying in a sleeping position, is well protected.~~

Because the reel (spool) of the conventional belt retractor can accommodate only a limited length of belt, it is possible that the length of the seat belt for the sleeping position is insufficient. ~~As exemplified in **Fig.** 1, a buckle assembly **8b, 8c** is provided with a release button **84c** and a~~ The length-adjustable belt~~, fastened to the seat frame, for the purpose of~~ compensate~~s~~ing for the length of seat belt **1** and accommodates the passenger, particularly when being obese, in all positions between the sleeping and normal position.

An anti-submarining buckle assembly **8d**, provided with a release button **84d**, is attached to the front portion of the seat cushion. This feature facilitates the obese passenger or a lady in a gown to restrain the thighs by plug-in connecting the anti-submarining latch plate **11** thereto.

~~The other end of shoulder belt **1.12** can be connected either to a coupling fitting **1.2a, 1.2b** (**Figs.** 12a, 12b, 18, 19) or to the belt retractor **13a** (belt retractor **13** shown in **Fig.** 18) having a coupling fitting **1.2b** in order to receive a number of energy absorbers to dissipate great impact energy and dampen strong vibration.~~

~~In another embodiment the shoulder belt **1.12a** consists of the transition buckle assembly **4c** and a shoulder latch plate **2a** (not shown), similar to latch plate **2**, which is plug-in connected to~~

~~— the upper buckle assembly **4, 4a to 4c, 14, 14a, 18, 18a, 18b, 18.1 to 18.3**, arranged in the seat backrest, in operation position or~~

~~— the assisting buckle assembly **16, 16a, 16b** in resting position.~~

~~When motor vehicles are already licensed, modification of different seats and three-point seat belts can easily be accomplished by arrangement of at least one buckle assembly, of the lower belt deflector **17**, of the second belt retractor **13a** and by collection of one-piece, detachable shoulder belts **1.12a** with different length. Furthermore, the latch plate **2a** can be detached from the buckle assembly by depressing the master release button **84**.~~

~~A first shoulder belt portion **1.1** is defined by the upper shoulder belt **1.12, 1.12a** and the lower shoulder belt portion **1.11**.~~

~~At an expensive modification or at new transport system the use of belt-feeding device **20, 20a to 20d** enhances the convenience and comfort, where the shoulder belt **1.12, 1.12a** having transition buckle assembly **4c** is a part thereof.~~

~~Evidently, the three-point seat belt **1c** in plug-in connection with the shoulder belt **1.12, 1.12a** serves as a transition solution for the multi-point seat belt **1, 1a to 1d** during the production.~~

~~In the above-mentioned embodiments to resolve the above-mentioned drawback **D3** the upper part of body is restrained by extending the shoulder belt portions crosswise in an X-shape~~

c1) when at least one latch plate **2** is plug-in connected to the buckle assembly of the seat backrest; *or*

c2) when a latch plate **2**, arranged to the end ER of the first shoulder belt portion **1.1** of a belt-feeding device **20a, 20b**, is plug-in connected to the buckle assembly of the seat backrest; *or*

c3) when the belt-feeding device **20, 20c, 20d** positions the first shoulder belt portion **1.1**, the belt end ER of which is arranged to or in the side SR of the seat backrest, from the operation position to a resting position.

These features c2) and c3) have the advantage that the common practise to operate the conventional three-point seat belt is preserved.

In order to resolve the above-mentioned drawbacks **D2** and **D4** great energy is absorbed and strong vibration is dampened by a large number of energy absorbers connected to the respective buckle assemblies **4, 4a to 4c, 4c, 7, 8, 8a to 8d, 9.1, 14, 14a, 15, 15a, 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3** (**Figs.** 1, 14, 19, 23) into which latch plates are inserted.

As shown in **Figs.** 1 and 14, the seat belt **1** is equipped with an anti-submarining latch plate **11**, which can be connected to one of the buckle assemblies **7, 8, 8a to 8d**, arranged in or to the seat frame **3.3**. When plug-in connected, the lap belt portion **1.3** is subdivided into two belt portions **1.3R, 1.3L**. Owing to the restraint of both thighs the submarining problem in front- or rear collision, in rollover or turbulence-related vibration of an aeroplane is resolved. Moreover, the passenger, lying in a sleeping position, is well protected.

Due to the plug-in connection of the anti-submarining latch plates **11, 25** with one of the anti-submarining buckle assemblies a lady in a long gown as well as a child are well protected from submarining. The anti-submarining belt portions, restraining a child's or baby's thighs with small circumference, are secured to the seat cushion by the latch plate **11**, plug-in connected to one of the anti-submarining buckle assemblies **8, 8a to 8d**, and the detachable anti-submarining latch plates **25**, plug-in connected to at least one pair of anti-submarining buckle assemblies 7 (**Figs.** 1, 23~~5~~). For safety reasons and easy access the anti-submarining latch plates, when not being used, are stored and secured in a storage box **25.5** of the seat (**Fig.** 5).

The lower belt deflector **17** comprises a housing having an attachment hole to receive a pin **17.1**. Both members can be made in one piece. If necessary, the pin **17.1** is surrounded by a sleeve **17.2** of plastics, having corrugation or knobs, which is a common part of the conventional D-ring **12**. This D-ring **12** can be replaced by the lower belt deflector **17**. The aperture of the belt deflector **17** to loosely guide the belt portion is dimensioned to such a size to retain the latch plate **2** in resting position, thus allowing the use as a three-point seat belt.

In the 1st embodiment ref. to **Figs.** 14, 17a, 17d the belt-feeding device **20** in resting position is provided with a device to countersink the belt-feeding plate **20.9** in the seat backrest to improve the overall impression of the seat-design, whereon the sales success depends.

When the passenger takes his seat, a drive apparatus, being activated,

- moves up over the head rest the belt-feeding plate **20.9** (**Fig.** 17a) and then the guide tube **20.1** with the operating arm **20.2**, whose belt ring **20.8** houses and loosely guides the first belt portion **1.1** (**Fig.** 17b);

- rotates the operating arm and the first shoulder belt portion over the head rest, his head and in front of the upper part of his body **95** at „β" (**Fig.** 14), where in a contact position a key of the operating arm projects through a receptacle of the belt feeding plate **20.9** or a clamping receptacle **20.11** of the belt feeding plate **20.9a** (**Figs.** 17c, e, f); and
- countersinks the belt feeding plate **20.9** or **20.9a** and the guide tube **20.1** with the operating arm **20.2** until reaching the operating position in which the first shoulder belt portion extends across over the upper part of his body and the drive apparatus is switched off (**Fig.** 17d).

To prevent the entanglement of the first belt portion **1.1** behind the seat, particularly when positioned furthest forward, that belt portion **1.1** in resting position is intercepted by the belt catching member **20.7, 20.7a** (**Figs.** 14, 17a, 17b).

When the seat **3c** (**Fig.** 23) has a high seat backrest, the curved guide tube **20.1** of belt feeding devices **20a** (**Fig.** 15) can be modified in a straight running operating arm **20.2** of the belt feeding device **20**.

In the 2nd or 3rd embodiment the belt feeding device **20a** or **20b** is provided with a height adjustable belt housing **20.4a** and radial adjustable tube **20.3** (**Figs.** 15, 16). Both devices differ from each other by the position of the guide tubes **20.1** on the seat backrest. Each guide tube can be driven by a drive apparatus, housed in the seat backrest. The guide tube **20.1** of the belt feeding device **20a** is pivotally attached in a stiff supporting tube **3.61** of the height adjustable head rest **3.6a**.

The height of „Δh" of belt housing **20.4a**, having a latch plate **2**, plug in connected to any buckle assembly **4, 14, 18**, is adjustable when the passenger moves two openings, facing each other, along the operating arm **20.2a**. Alternatively, the passenger can move a handle **5.2**, such as locking handle **27.5** of the height and width adjusting mechanism **27, 27a** (**Figs.** 15, 19 to 22), to adjust the height of „Δh" of upper belt deflector **5b**.

The belt feeding devices **20a, 20b** have to meet the following criteria:

- Passengers freely get in and out of the vehicle compartment thanks to the distances of „a" and „b" between the post section **91** and operating arm **20.2a** (**Fig.** 16) in resting position; and
- the device, when moved, doesn't interfere with the head rest **3.6a**, height adjustable about „Δh_K", and with the head of the passenger with/without hat **92**.

Regarding the kinematics of the height adjustable belt housing **20.4a** with the latch plate **2** from the operating position to the resting position, the trajectories of „Ba2" and „Bb" are not in the range of a hat thanks to a radial adjustable tube **20.3** incorporated into the operating arm **20.2a**. Without the radial adjustable tube **20.3** the operating arm in the trajectory of „Ba1" interferes with that hat.

In the 4th and 5th embodiment ref. to **Figs.** 18, 19 the belt feeding devices **20c, 20d** differ from each other by the rotatory movement of the operating arm **20.2**, whose guide tube **20.1** is pivotally attached to a bearing casing **20.10**. Preferably, upon the rotation about the head, the translatory and rotatory movement of belt are synchronised.

To form the upper part of the seat backrest frame **3.4d** a pair of angle fittings **26a**, a pair of rollover tubes **20.2b** and a pair of side girders **27.1a** or four tubes **27.1** (not drawn) are form and/or force locking connected to each other by connecting pins **26.2**, **26.3** (drawn with dotted lines) and/or by welding, bolting, glueing and/or riveting. The belt housing **20.4c** or **20.4d**, having a moveable safety bracket **20.6**, is guided by rollover tubes **20.2b** and driven

by an electrical motor **20.5** along the threaded spindle **20.1a**, fastened to both angle fittings **26a**, from the resting position (drawn with dotted lines) to the operating position, and back again. In the operating position the holes of the rollover tube **20.2b** and belt housing **20.4d** are aligned with each other, thus permitting the legs of the safety bracket **20.6**, loaded in the event of rollover of a convertible, roadster or sport-utility vehicle, to project therethrough and clamp or jam the first shoulder belt portion **1.1**.

Upon plug-in connection of the latch plate **2** with the buckle assembly **4, 4a, 4b** the belt end ER of belt portion **1.1** is connected to the coupling fitting **1.2a, 1.2b** (**Figs.** 12a, 12b), whereto a number of energy absorbers is attached to absorb energy. In a cost-saving embodiment without the latch plate **2** and buckle assembly, the belt end ER of belt portion **1.1** is directly connected to the coupling fitting **1.2a** or **1.2b** (**Fig.** 18) to receive energy absorbers, the retaining elements of which are fastened to the seat backrest frame **3.4d**. In order to absorb great energy and damp strong vibration in the event turbulence-related vibrations of an aeroplane or accident of a fast speeding car or high-speed train, the belt retractor **13**, coupling fitting **1.2b** of which is connected to energy absorbers, is moveable attached to the oblong holes of a stiff plate **13.3**, fastened to the seat backrest frame in the side SR so that the other belt end EL can be exploited to receive additional energy absorbers. In excess of threshold value the belt retractor pulls the clamping elements along the respective retaining elements to absorb energy and damp vibration.

The lower belt deflector **17** comprises a housing having an attachment hole to receive a pin **17.1**. Both members can be made in one piece. If necessary, the pin **17.1** is surrounded by a sleeve **17.2** of plastics, having corrugation or knobs, which is a common part of the conventional D-ring **12**. This D-ring **12** can be replaced by the lower belt deflector **17**. The aperture of the belt deflector **17** to loosely guide the belt portion is dimensioned to such a size to retain the latch plate **2** in resting position, thus allowing the use as a three-point seat belt.

In the 1st embodiment ref. to **Figs.** 14, 17a, 17d the belt-feeding device **20** in resting position is provided with a device to countersink the belt-feeding plate **20.9** in the seat backrest to improve the overall impression of the seat design, whereon the sales success depends.

When the passenger takes his seat, a drive apparatus, being activated,

- moves up over the head rest the belt-feeding plate **20.9** (**Fig.** 17a) and then the guide tube **20.1** with the operating arm **20.2**, whose belt ring **20.8** houses and loosely guides the first belt portion **1.1** (**Fig.** 17b);
- rotates the operating arm and the first shoulder belt portion over the head rest, his head and in front of the upper part of his body **95** at „β" (**Fig.** 14), where in a contact position a key of the operating arm projects through a receptacle of the belt-feeding plate **20.9** or a clamping receptacle **20.11** of the belt-feeding plate **20.9a** (**Figs.** 17c, e, f); and
- countersinks the belt-feeding plate **20.9** or **20.9a** and the guide tube **20.1** with the operating arm **20.2** until reaching the operating position in which the first shoulder belt portion extends across over the upper part of his body and the drive apparatus is switched off (**Fig.** 17d).

To prevent the entanglement of the first belt portion **1.1** behind the seat, particularly when positioned furthest forward, that belt portion **1.1** in resting position is intercepted by the belt-catching member **20.7, 20.7a** (**Figs.** 14, 17a, 17b).

When the seat **3c (Fig.** 23) has a high seat backrest, the curved guide tube **20.1** of belt-feeding devices **20a (Fig.** 15) can be modified in a straight-running operating arm **20.2** of the belt-feeding device **20**.

In the 2nd or 3rd embodiment the belt-feeding device **20a** or **20b** is provided with a height-adjustable belt housing **20.4a** and radial-adjustable tube **20.3 (Figs.** 15, 16). Both devices differ from each other by the position of the guide tubes **20.1** on the seat backrest. Each guide tube can be driven by a drive apparatus, housed in the seat backrest. The guide tube **20.1** of the belt-feeding device **20a** is pivotally attached in a stiff supporting tube **3.61** of the height-adjustable head rest **3.6a**.

The height of „Δh" of belt housing **20.4a**, having a latch plate **2**, plug-in connected to any buckle assembly **4, 14, 18**, is adjustable when the passenger moves two openings, facing each other, along the operating arm **20.2a**. Alternatively, the passenger can move a handle **5.2**, such as locking handle **27.5** of the height- and width-adjusting mechanism **27, 27a (Figs.** 15, 19 to 22), to adjust the height of „Δh" of upper belt deflector **5b**.

The belt-feeding devices **20a, 20b** have to meet the following criteria:

- Passengers freely get in and out of the vehicle compartment thanks to the distances of „a" and „b" between the post section **91** and operating arm **20.2a (Fig.** 16) in resting position; and
- the device, when moved, doesn't interfere with the head rest **3.6a**, height-adjustable about „Δh_K", and with the head of the passenger with/without hat **92**.

Regarding the kinematics of the height-adjustable belt housing **20.4a** with the latch plate **2** from the operating position to the resting position, the trajectories of „Ba2" and „Bb" are not in the range of a hat thanks to a radial-adjustable tube **20.3** incorporated into the operating arm **20.2a**. Without the radial-adjustable tube **20.3** the operating arm in the trajectory of „Ba1" interferes with that hat.

In the 4th and 5th embodiment ref. to **Figs.** 18, 19 the belt-feeding devices **20c, 20d** differ from each other by the rotatory movement of the operating arm **20.2**, whose guide tube **20.1** is pivotally attached to a bearing casing **20.10**. Preferably, upon the rotation about the head, the translatory and rotatory movement of belt are synchronised.

To form the upper part of the seat backrest frame **3.4d** a pair of angle fittings **26a**, a pair of rollover tubes **20.2b** and a pair of side girders **27.1a** or four tubes **27.1** (not drawn) are form- and/or force-locking connected to each other by connecting pins **26.2**, **26.3** (drawn with dotted lines) and/or by welding, bolting, glueing and/or riveting. The belt housing **20.4c** or **20.4d**, having a moveable safety bracket **20.6**, is guided by rollover tubes **20.2b** and driven by an electrical motor **20.5** along the threaded spindle **20.1a**, fastened to both angle fittings **26a**, from the resting position (drawn with dotted lines) to the operating position, and back again. In the operating position the holes of the rollover tube **20.2b** and belt housing **20.4d** are aligned with each other, thus permitting the legs of the safety bracket **20.6**, loaded in the event of rollover of a convertible, roadster or sport-utility vehicle, to project therethrough and clamp or jam the first shoulder belt portion **1.1**.

Upon plug-in connection of the latch plate **2** with the buckle assembly **4, 4a, 4b** the belt end ER of belt portion **1.1** is connected to the coupling fitting **1.2a, 1.2b (Figs.** 12a, 12b), whereto a number of energy absorbers is attached to absorb energy. In a cost-saving embodiment without the latch plate **2** and buckle assembly, the belt end ER of belt portion **1.1** is directly connected to the coupling fitting **1.2a** or **1.2b (Fig.** 18) to receive energy absorbers, the retaining elements of which are fastened to the seat backrest frame **3.4d**. In

~~order to absorb great energy and damp strong vibration in the event turbulence related vibrations of an aeroplane or accident of a fast speeding car or high speed train, the belt retractor 13, coupling fitting 1.2b of which is connected to energy absorbers, is moveable attached to the oblong holes of a stiff plate 13.3, fastened to the seat backrest frame in the side SR so that the other belt end EL can be exploited to receive additional energy absorbers. In excess of threshold value the belt retractor pulls the clamping elements along the respective retaining elements to absorb energy and damp vibration.~~

In the 1st, ~~and~~ 2nd and 3rd embodiment (**Figs.** ~~12, 21~~3a to 3c) the buckle assembly **4a, 4b, 4c** is form- and/or force-locking connected to the seat-backrest frame. For the convenience of the passenger when egressing from the vehicle and in cases of emergency the following embodiments of detachment are proposed:
To disconnect the latch plates **2, 11** and/or **25** from the ~~buckle assemblies 14, 14a, 15, 15a (Fig. 1) and~~ upper buckle assemblies **4, 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3** (**Figs.** ~~23~~1 and 5) of the seat arrangement, particularly in the case of ~~for~~ children, as well as from the anti-submarining buckle assemblies **7, 8, 8a to 8d** (**Figs.** 1, ~~14~~), the master release button **84**, when depressed, activates the release cables **4.2** and/or electrical release-motors **4.2b**, which pull the release button **84a** and/or **84b** of all the buckle assemblies (**Figs.** ~~12a~~3a, ~~12b~~3b, ~~21~~3c).
~~When depressing the master release button 84 the drive apparatus of the belt feeding device 20, 20a to 20d returns the first shoulder belt portion 1.1 from the operating position to the resting position.~~

~~According to the traffic- or flight law during the travel or turbulence related flight passengers must remain belted. The need for a belted mother becomes apparent, when she must take care of her frightened children seating on the rear seat. The separately operated release button 84o, 84d, when depressed, detaches only the latch plates 11, 25 of the lap belt portion from the assemblies 7, 8, 8a, 8d (Figs. 1, 23) to annul the protection from submarining.~~

By law passengers travelling in a motor vehicle or experiencing flight-turbulence ~~According to the traffic- or flight law during the travel or turbulence related flight passengers~~ must remain belted. The need for a belted mother to turn around becomes apparent, when she must attend ~~take care of her frightened~~to her children ~~seating~~ sitting on the rear seat. The separately operated release buttons **84o, 84d, 84e, 84f**, when depressed, detaches only the anti-submarining latch plates **11, 25** of the lap belt portions from the assemblies **7, 8, 8a, to 8d** (**Figs.** 1, 4 and ~~23~~5) to free the mother and/or children from the anti-submarining ~~annul~~ theprotection ~~from submarining~~while the mother and/or children remain belted. The anti-submarining buckle assemblies **7, 8, 8a**, whose housings are located in the seat cushion **3.1, 3.1a to 3.1d**, have the common release button **84o** on the seat.

In the 1st and 2nd embodiments the belt **1, 8.1** (seat belt 1 or the length-adjustable belt **8.1**) has a property of limited energy absorption **70, 80** which can be exploited to release energy (belt force), stored by the belt webbing, upon fracturing a number of sites of predetermined fracture in excess of the respective threshold values. The threshold values, laid out lower than the injury-relevant threshold values, are the released subenergies, the addition of which is equal to the total energy or total belt force.
A number of overlapped belt portions **1.10, 1.11, 1.12,...., 1.1n** (three overlapped belt portions shown in **Fig.** 12) is sewn together by seams 60_i **to** 60_n, where i = 1 to n. Different threshold values of sites of predetermined fracture are achieved by

- yarns having different yield strength **60_1, 60_4, 60_9**;
- single-knit seams **60_1, 60_2, 60_4, 60_m, 60_n** made from yarn sewn in single row;
- double-knit seams **60_3, 60_9** made from yarn sewn in double row and/or
- triple-knit seam **60_8** made from yarn sewn in triple row.

A number of stretching belt portions **62.1 to 62.n** and a number of overlapped belt portions **1.10, 1.11, 1.12, ... , 1.1n** (two and three overlapped belt portions shown in **Fig.** 13) are sewn together by seams **61_1 to 60_n**, where i = 1 to n. Different threshold values of sites of predetermined fracture are achieved by

- seam stitches **61_1 to 61_4** having different width „w_1" to „w_4" (**Fig.** 14);
- different number of overlapped belt portions;
- yarns having different yield strength **61_1, 61_2, 61_3**,...;
- stretching belt portions **62.1, 62.2, 62.3, 62.4,... 62.n**;
- single-knit seams **61_1, 61_4, 61_5, 61_6, 61_7**,... made from yarn sewn in single row;
- double-knit seams **61_2, 61_9**,... made from yarn sewn in double row; and/or
- triple-knit seams **61_f, 61_k** ,...made from yarn sewn in triple row.

In case the restraint of the belted passenger becomes slack because of

- the conventional belt retractor capable of retracting an excess belt portion at a total length of about 30 cm in a real-world accident or during in-flight turbulence,
- large elongation rate of the belt webbing of anti-submarining belt portions **1.3R, 1.3L** and/or length-adjustable belt **8.1** (**Fig.** 6);
- the total length of the overlapped belt portions, when being stretched, and/or
- the total length of stretching belt portions, when being stretched,

he moves out of the seat cushion and falls onto the floor. In worst case, he, when freeing himself of the restraint, can be ejected out of the motor vehicle. In order to ensure the survival chance engineers must take care of the limitation of energy absorption depending on the permissible elongation of the anti-submarining belt portions **1.3R, 1.3L** and/or the length-adjustable belt **8.1**. Tests can determine that permissible elongation up to which the anti-submarining seat-belt assembly in co-operation with the energy-absorbing seat belt **1** and/or the energy-absorbing length-adjustable belt **8.1**, attached to a stiff member **64** of the seat frame (**Fig.** 13), always ensures the survival chance of the belted passenger in any accident. In order to absorb great energy and dampen strong vibration vibration-dampening energy absorbers must be put into use.

„VIN" **81**, an acronym for Vehicle Identification Number, is engraved on a surface of any engraved belt portion, for example **1.11**, or affixed thereto (**Figs.** 12, 13). To conceal it from unauthorized persons, in particular car thieves, intending to manipulate, this surface is covered by a covering belt portion , for example **1.10**, and both belt portions are sewn together. If necessary, the manufacturing date can be added thereto. This feature helps Police and Insurers, getting the information only from the car corp.,

- discover and identify stolen cars having „VINs" forged by the car thieves;
- check the seat belts whether they are original ones replacing the ones worn due to great elongation in real-world accidents or during in-flight turbulence; and/or
- check the seat belts whether they are the ones approved by the car corps. There is a market for selling counterfeit seat belts, unapproved by the car corps.

~~In the 1st embodiment (**Figs.** 19 to 21) the height- and width-adjusting mechanism **27** comprises a frame **29**, buckle assembly **18.3, 19.3**, a pair of tubes **27.4**, members **27.5 to 27.9** and a pair of tubes **27.1** having a plurality of locking slots, in form- and force-locking connection with an angle fitting **26a**. The frame **29** consists of a pair of outer tubes **27.3**, a~~

~~pair of tubes **27.2** and a connecting member of all tubes. The locking handle **27.5** is form- and force-locking connected to the slots of the inner tubes **27.4**.~~

~~These inner tubes **27.4**, inserted into the outer tubes **27.3**, are pre-loaded by the springs **27.6**. Each spring **27.6** on a sleeve **27.7**, secured by pin **27.8**, protruding through the holes of the inner tube **27.4**, presses against the spring rest **27.9** of the outer tube **27.3**.~~

~~The locking handle **27.5** is in engagement with a pair of locking slots of tubes **27.1**. The locking handle **27.5**, when pulled out from both slots, is detached therefrom. The height of mechanism **27** and buckle assembly can be adjusted~~

~~The outer tube **27.3** is provided with a plurality of locking slots q, r, s etc., drawn with dotted lines in **Figs.** 20, 22.~~

~~After the pawl **18.10**, pre-loaded by the spring **18.5**, is detached from the locking slot r by its movement in the direction of arrow (**Fig.** 21), the housing **18.12**, form-locking connected to the buckle assembly **4c**, can be moved along both outer tubes **27.3**.~~

~~Belt-detachable U-shaped latch plates **25** offer the passengers a feature to adapt their body proportions to the appropriate attachment points into which the latch plates **25** are inserted (**Figs.** 19, 23). Any belt portion, such as **1.1, 1.2**, is loosely guided thereby, secured by a quick-release pin **25.1** thereof and detached therefrom by pulling the quick-release pin.~~

~~For juxtaposed seats in vehicles, buses, trains and aeroplanes it is recommended to use a single locking handle **27.5** to operate the 2nd embodiment of the height- and width-adjusting mechanism **27a** of each seat **3c** having, for example, three pairs of openings **18.1 /19.1 to 18.3 / 19.3** to receive a pair of latch plates (**Figs.** 22, 23).~~

~~The frame **29a** consists of two pairs of outer tubes **27.3**, two pairs of tubes **27.2**, a pair of connecting members of all tubes and members **18.3, 19.3, 27.6 to 27.9a, 27.11**, attached to the outer tubes **27.3**.~~

~~The locking handle **27.5** is form- and force-locking connected to slots of the inner tubes **27.4** by the pins **27.12**. After inserting these inner tubes into the outer tubes **27.3** the locking plate **27.10** is form- and force-locking connected to the slots of the inner tubes and to the pins **27.12**.~~

~~After securing the spring rest **27.9a** by the retaining rings **27.11**, both sleeves **27.7a** by the pins **27.8**, protruding through the holes of inner tubes **27.4** and oblong holes of outer tubes **27.3**, the inner tubes with locking handle **27.5** are pre-loaded by springs **27.6**. The locking handle **27.5**, when pulled out from both slots, is detached therefrom. The height of height- and width-adjusting mechanism **27a** can be adjusted.~~

Although the present invention has been described and illustrated in detail, it is clearly understood that the terminology used is intended to describe rather than limit. Many more objects, embodiments, features and variations of the present invention are possible in light of the above-mentioned teachings. Therefore, within the spirit and scope of the appended claims, the present invention may be practised otherwise than as specifically described and illustrated.

What is claimed:

Claims 1-13, 15 (original)

Claim 14 (amended): *the* free-moving anti-submarining buckle assembly > *a* free-moving anti-submarining buckle assembly and length-adjustable belt ***(8.1)***.

Claim 16 (amended): > *vibration-dampening* .. and length-adjustable belt ***(8.1)***.

Claim 17 (amended)

Claims 18 to 24 (new)

Claim 19 > 25 (amended): > *vibration-dampening*

Claim 20 > 26 (amended): > first end *portion*, a second *end portion*.. and .. to *one of* the anti-submarining buckle assemblies~~y~~.

14. (amended) The anti-submarining seat-belt assembly according to claim **1**, wherein ~~the~~ a free-moving anti-submarining buckle assembly **(8b, 8c)** has a housing, free-moving on the seat cushion and provided with a release button **(84e, 84f)**, and a length-adjustable belt **(8.1)**, a free end of which is attached to the seat frame.

16. (amended) The anti-submarining seat-belt assembly according to claim **14**, wherein the length-adjustable belt **(8.1)** is provided with vibration-dampening energy absorbers.

17. (amended) The anti-submarining seat-belt assembly according to claim **14**, wherein the length-adjustable belt **(8.1)**, havings a property of limited ~~absorbing~~ energy absorption **(70, 80)**, is provided with sites of predetermined fracture having threshold values.

18. (new) The anti-submarining seat-belt assembly according to claim **17**, wherein the sites of predetermined fracture have different threshold values.

19. (new) The anti-submarining seat-belt assembly according to claim **18**, wherein the different threshold values are determined by different number of overlapped belt portions.

20. (new) The anti-submarining seat-belt assembly according to claim **18**, wherein the different threshold values are determined by seam stitches having different width.

21. (new) The anti-submarining seat-belt assembly according to claim **18**, wherein the different threshold values are determined by yarns having different yield strength.

22. (new) The anti-submarining seat-belt assembly according to claim **18**, wherein the different threshold values are determined by seams made from yarn sewn in different number of rows.

23. (new) The anti-submarining seat-belt assembly according to claim **1**, wherein a Vehicle Identification Number **(81)**, arranged on a surface of an engraved belt portion of the seat belt, is concealed from unauthorized persons, intending to manipulate, when this surface is covered by a covering belt portion and both belt portions are sewn together.

24. (new) The anti-submarining seat-belt assembly according to claim **23**, wherein a manufacturing date, added to the Vehicle Identification Number **(81)**, is arranged on the surface of the engraved belt portion of the seat belt.

~~19~~**25.** (amended) The anti-submarining seat-belt assembly according to claim **1**, wherein the anti-submarining buckle assembly is provided with a coupling fitting **(1.2a, 1.2b)** to receive vibration-dampening energy absorbers.

~~20~~**26.** (amended) An anti-submarining seat-belt assembly for increasing survival chance of a passenger of a transport system in an accident or during in-flight turbulence, comprising

a two-point seat belt, which is a lap belt portion, a first end portion of which is fastened to a lower belt deflector **(17)** and a second end portion is loosely attached to a main latch plate **(9)**;

a main buckle assembly **(9.1)**, having a master release button **(84)** and attached to a stiff first transport-system member, generally representing a floor of the transport system adjacent to a first seat-side or a seat-cushion frame at the first seat-side or a mid-tunnel of a motor vehicle adjacent to the first seat-side;

the lower belt deflector **(17)**, attached to a stiff second transport-system member, ~~which,~~ generally representing the floor of the transport system adjacent to a second seat-side or the seat-cushion frame at the second seat-side or a post section of the motor vehicle adjacent to the second seat-side or a side rail of the motor vehicle adjacent to the second seat-side;

at least two latch plates **(9, 11, 25)**, the first of which is the main latch plate **(9)** and the second is an anti-submarining latch plate **(11, 25)**, moveable along the lap belt portion; and

anti-submarining buckle assemblies, attached to a seat frame of a seat, generally representing the seat-cushion frame or a seat-backrest frame;

whereby

a lower part of the ~~body part of a~~ body **(96)** of the passenger is restrained by the lap belt portion when the main latch plate **(9)** is plug-in connected to the main buckle assembly **(9.1)**; and

the lap belt portion is subdivided into two anti-submarining belt portions **(1.3R, 1.3L)** to restrain thighs of the passenger when the anti-submarining latch plate is plug-in connected to one of the anti-submarining buckle assemblies~~y~~.

ABSTRACT

Seat belts of a transport system are provided with anti-submarining seat-belt assemblies. A lap-belt portion of each assembly, restraining the lower part of the body ~~part~~ of a belted passenger, is subdivided into two anti-submarining belt portions, which properly restrain the thighs when plug-in connecting at least one anti-submarining latch-plate to one of the anti-submarining buckle assemblies, all of which, equipped with energy absorbers, are arranged in a seat cushion. As a result, the energy-absorbing, anti-submarining seat-belt assembly substantially lowers great belt force in an accident, reduces the elongation of the seat belt and prevents submarining.

A separately operated release button, when depressed, frees the passenger from the anti-submarining protection.

Ease of use is ensured by one-click operation of a master release-button, which, when depressed, releases all latch-plates.

Detachable anti-submarining latch plates, when not in use, are stored in a storage box. When needed they are attached to the lap-belt portion.

Annotated Marked-up Drawing of 8/2
Anti-submarining seat-belt assembly, 10/690,742; G6A4; Giok Djien Go
The length-adjustable belt of the anti-submarining buckle assembly 8b is denoted by 8.1.

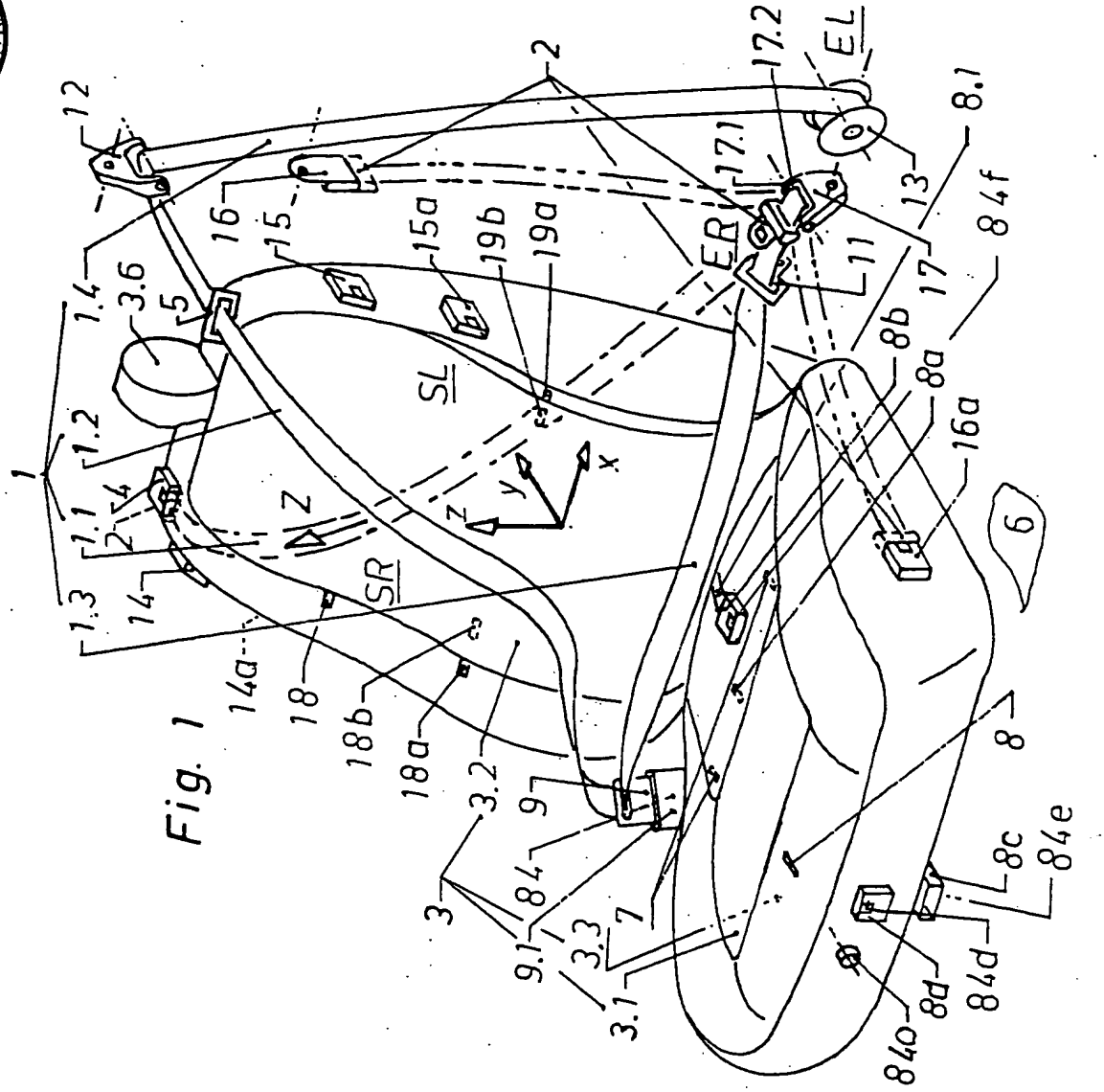


Fig. 1

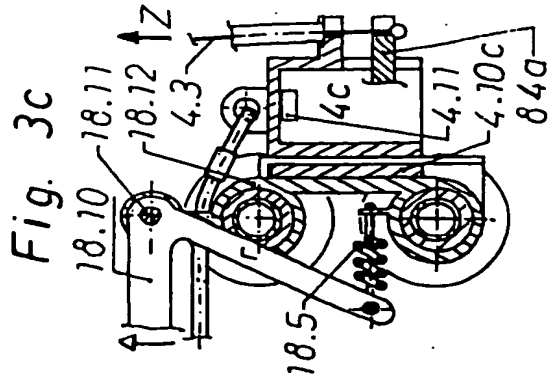


Fig. 3c

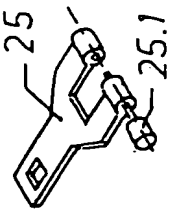


Fig. 2

Annotated Marked-up Drawing of 8/4
Anti-submarining seat-belt assembly, 10/690,742; Giok Djien Go
The reference number 2 of latch plate is replaced by 25; 11 in Fig. 4.
The storage box in Fig. 5 is denoted by a reference number 25.5

Fig. 4

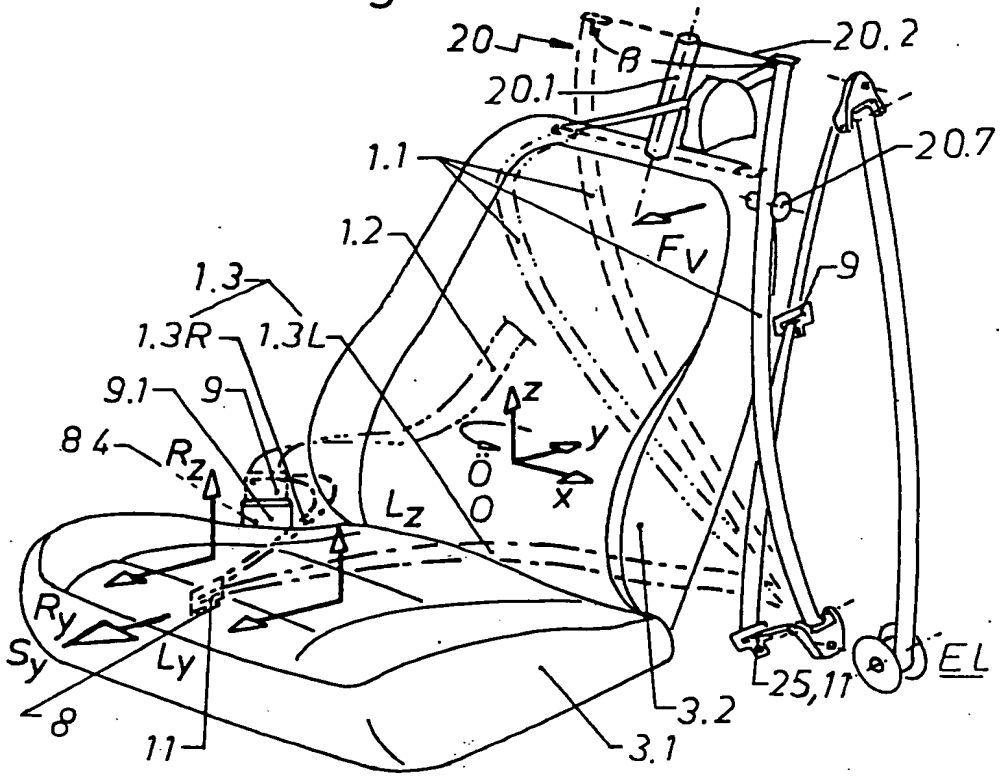
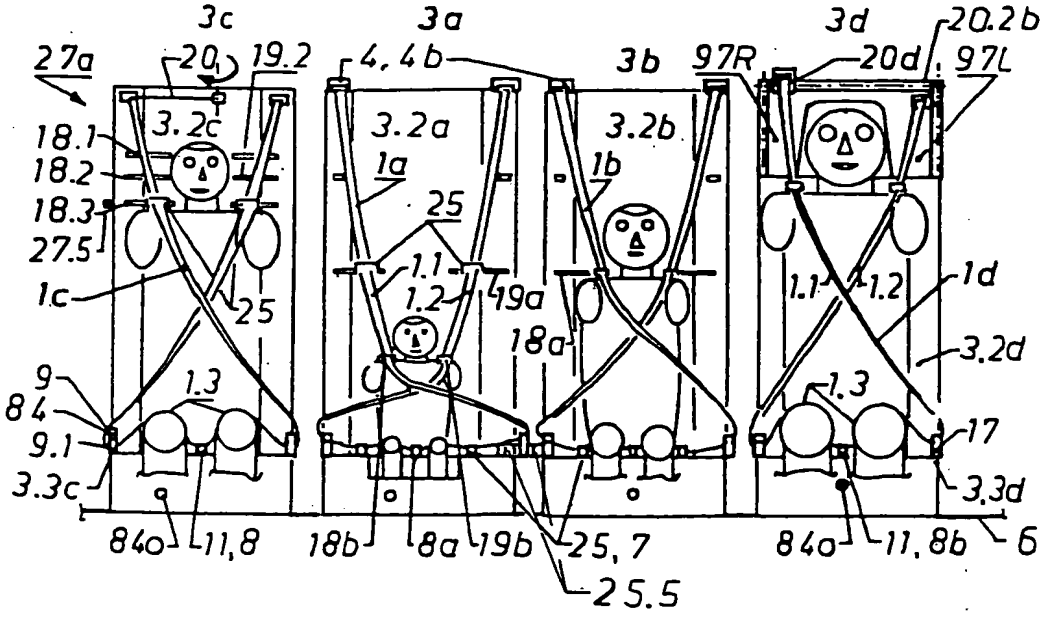


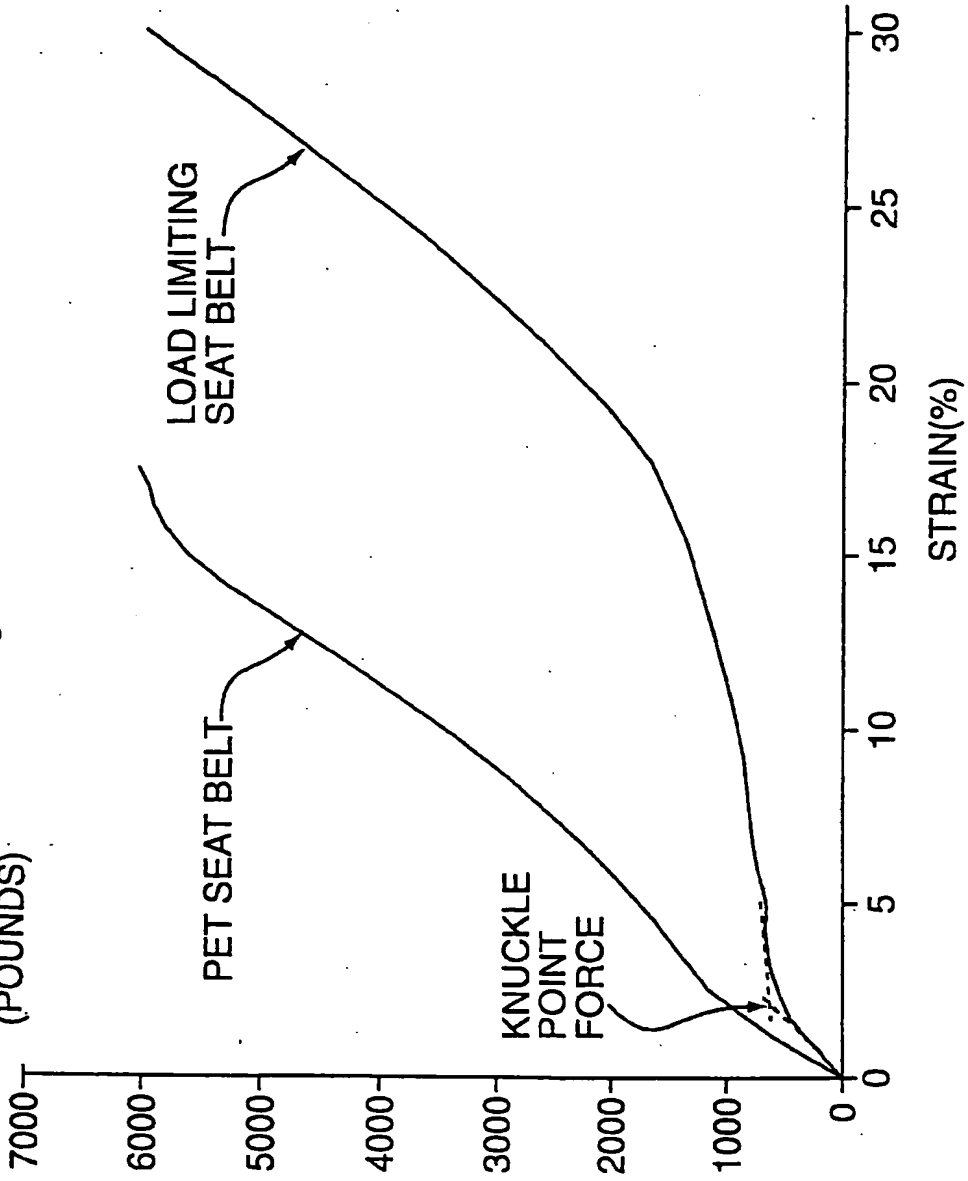
Fig. 5



Annotated Marked-up Drawing of 8/5
Anti-submarining seat-belt assembly, 10/690,742; Giok Djien Go
Prior Art is changed into PRIOR ART in Fig. 7.
Fig. 6 shows a diagram of PCT/US99/13662.

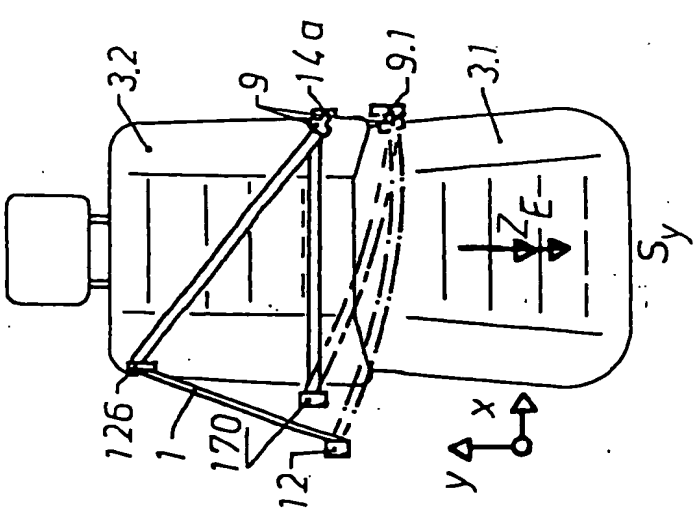
PRIOR ART

Fig.6



PRIOR ART

Fig. 7



Annotated Marked-up Drawing of 8/6
Anti-submarining seat-belt assembly, 10/690,742; G6A4; Giok Djien Go
In response to the objection Figs. 8 and 9 of US 5,524,928 are shown.

Fig. 9 PRIOR ART

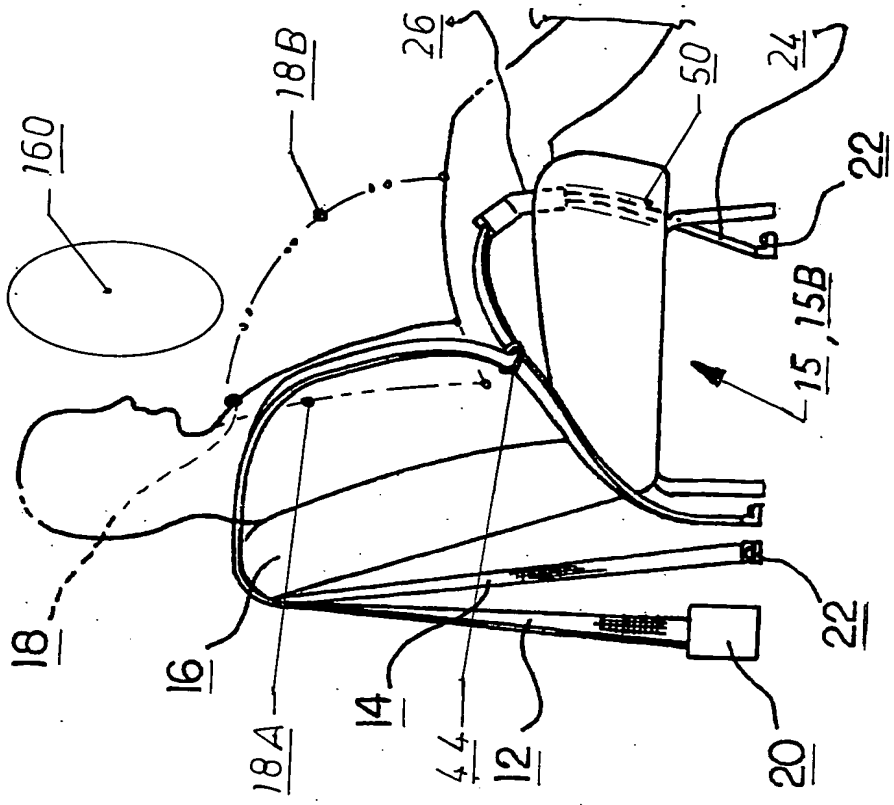
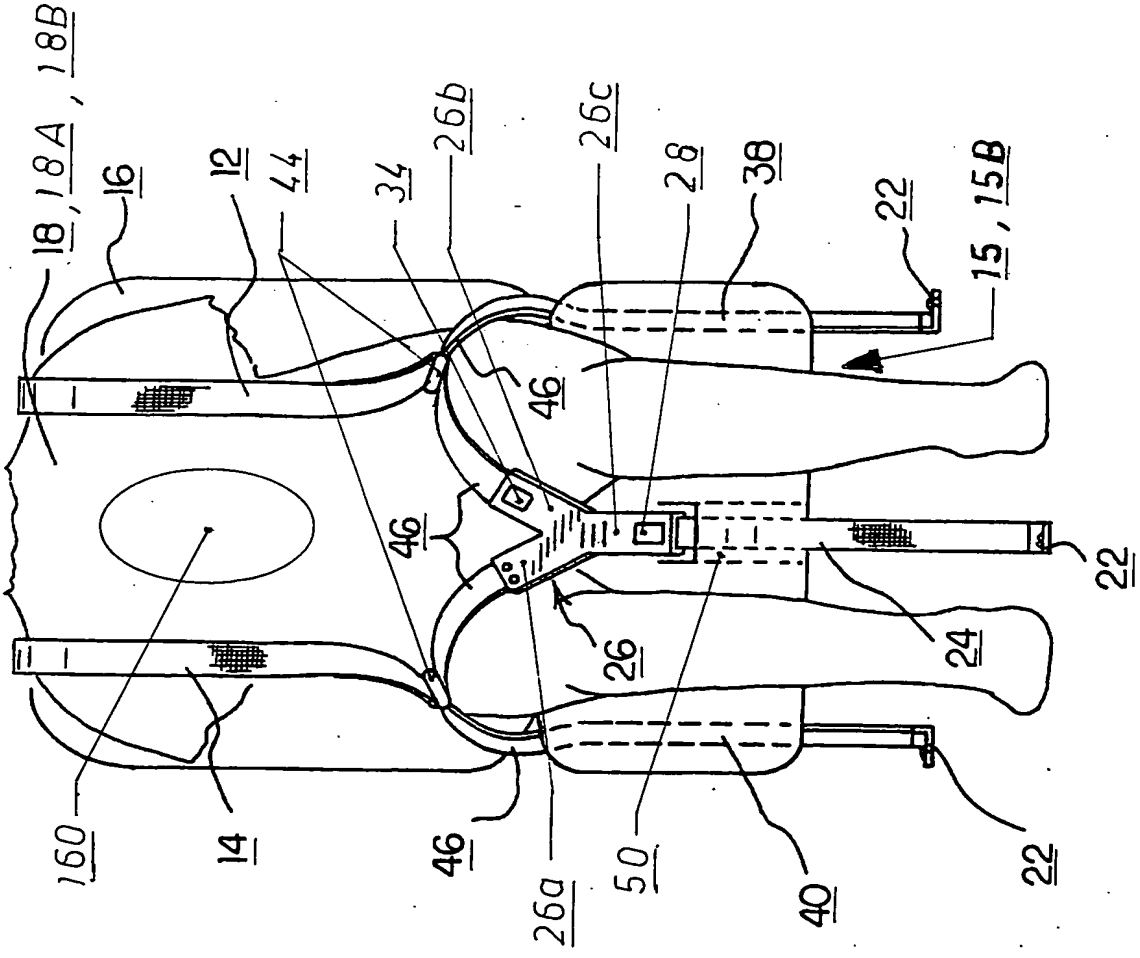


Fig. 8 PRIOR ART



Annotated Marked-up Drawing of 8/7
Anti-submarining seat-belt assembly, 10/690,742; G6A4; Giok Djien Go
In response to the objection Figs. 10 and 11 of DE 196 55 051 C2 are shown.

Fig. 10

PRIOR ART

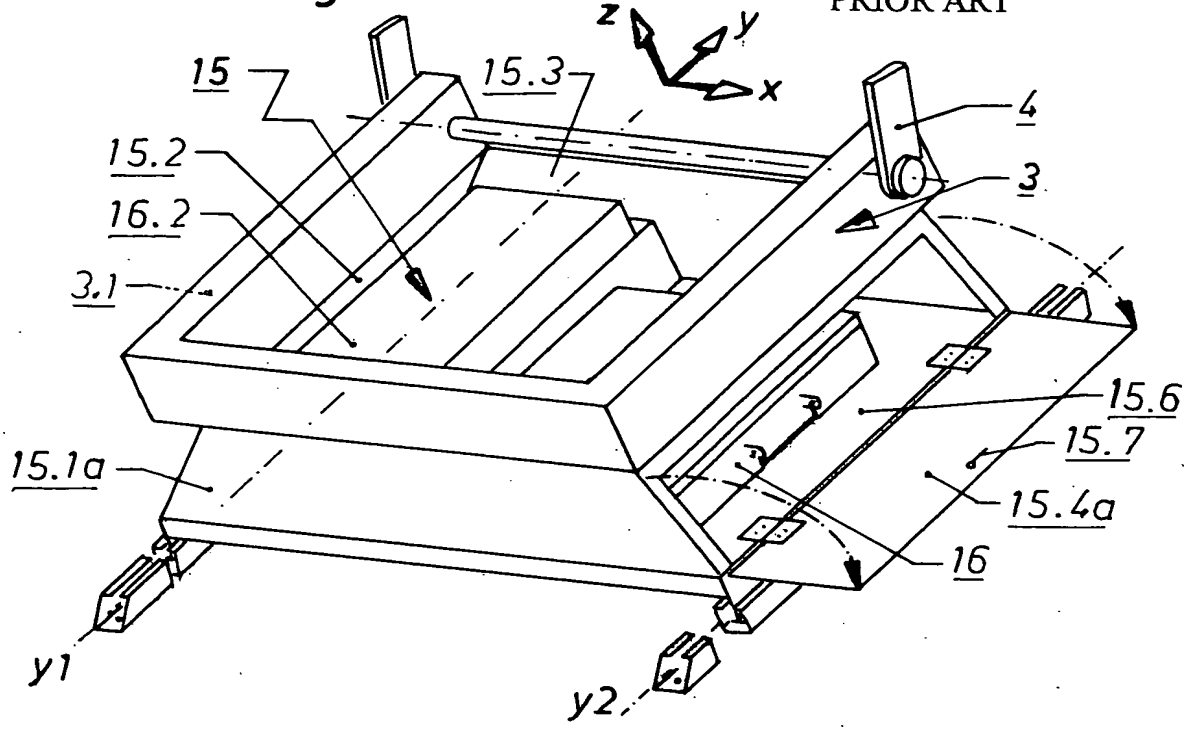
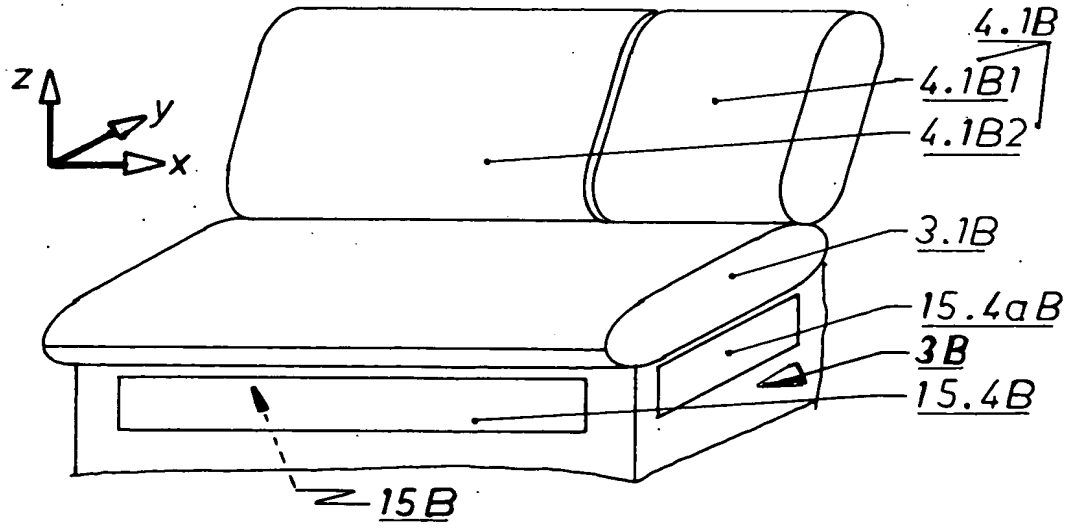


Fig. 11

PRIOR ART



Annotated Marked-up Drawing of 8/8
Anti-submarining seat-belt assembly, 10/690,742; G6A4; Giok Djien Go
The length-adjustable belt 8.1 as well as the seat belt are characterized by a property of absorbing energy 70, 80, shown in Figs. 12 to 14.

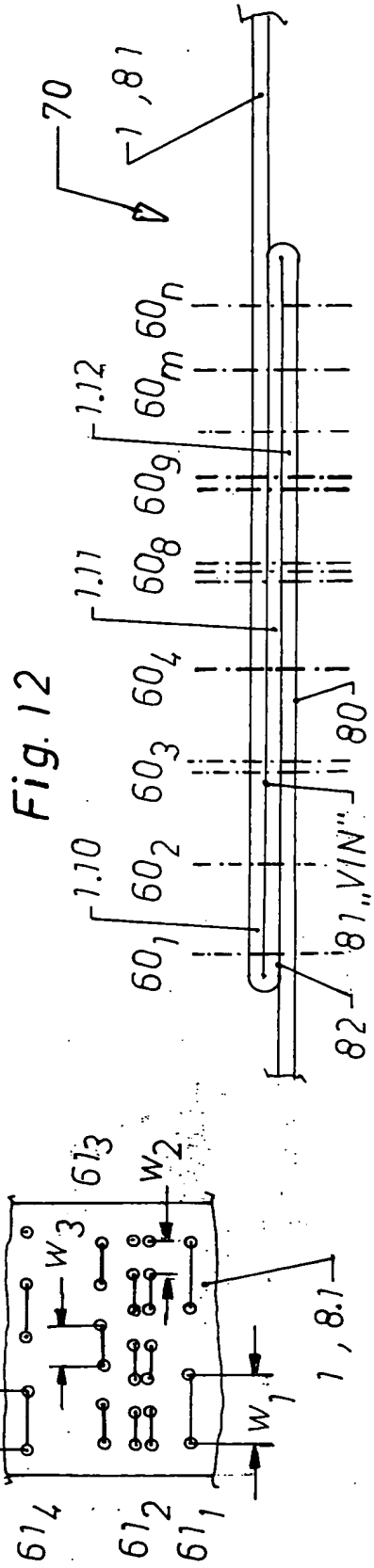


Fig. 12

Fig. 14

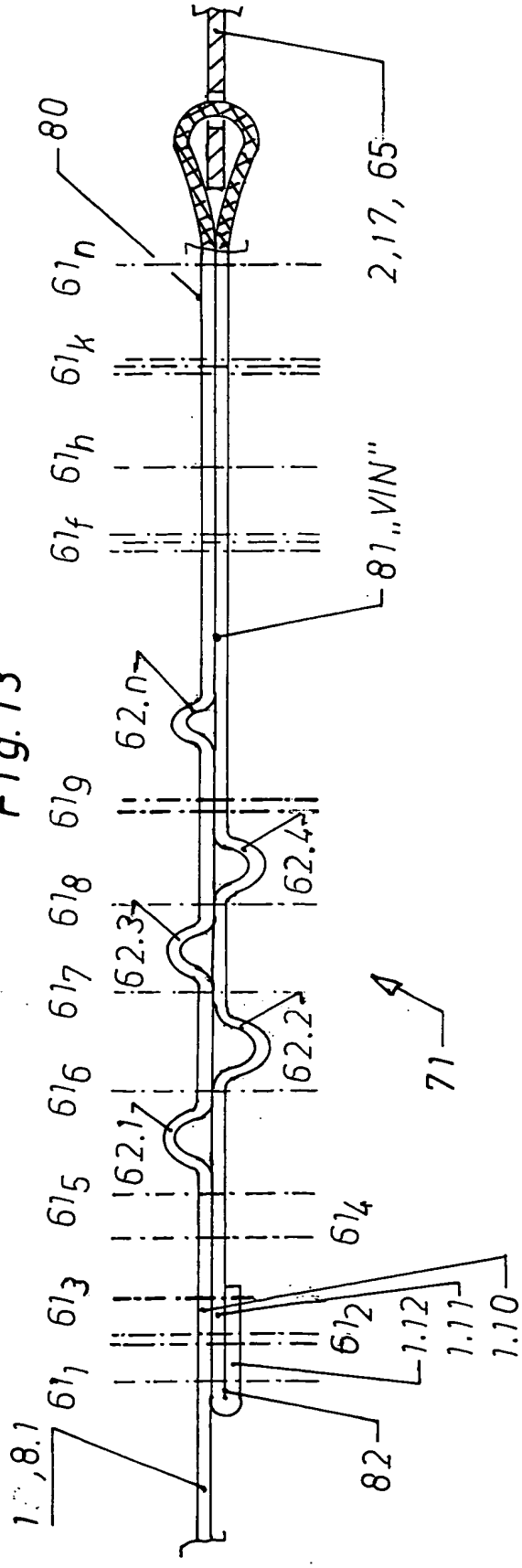


Fig. 13